Environmental Assessment for Experimental Release of Elk (*Cervus elaphus*) in the Great Smoky Mountains National Park

Prepared By

Great Smoky Mountains National Park
107 Park Headquarters Road
Gatlinburg, TN 37738

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SUMMARY

This environmental assessment (EA) is part of a 10-year process that has evaluated the experimental release of elk in the Great Smoky Mountains National Park (GRSM). During the last decade, GRSM biologists, supported by a host of national experts on elk management and wildlife diseases, have supported, developed, and/or assembled hundreds of reports and documents that aid the decision-making process of experimentally releasing elk in the GRSM. The GRSM prepared a reintroduction action plan and decision document in January 2000 that explored elk source locations and release areas in support of an experimental release effort.

This EA has been prepared to meet the requirements of the following federal acts and guidelines:

- National Environmental Policy Act of 1969 (NEPA)
- Council on Environmental Quality (CEQ) Guidelines - 1978 (40 CFR 1500-1508)
- National Park Service (NPS) Guidance Document - NPS-12 (National Environmental Policy Act Guidelines) (USDI NPS 1997).

The EA evaluates two alternatives; these are:

- Alternative A: No Action
- Alternative B: Experimental Release of Elk in the GRSM (Preferred Alternative).

If selected, the proposed action will be implemented in three phases:

- Phase I * – Experimental Release and Data Collection – The experimental release will be a controlled soft release of 75-90 elk over a three-year period (2001-2003) and data collection through 2004. Monitoring will continue through 2005.

- Phase II * – Data Evaluation – Evaluation of data by University of Tennessee, US Geological Service, and GRSM biologists will actually begin before the completion of Phase I. Phase II is scheduled to be completed within one year of the completion of Phase I (2005).

- Phase III * – Elk Management - Phase III will implement one of the following two actions:

    1) Evaluation of an elk reestablishment program to include a long-term management plan
    2) Remove of elk from the GRSM ecosystem [2006 +].

* The timetable of events described is contingent upon completion of the Environmental Assessment and issuance of the FONSI (Finding Of No Significant Impact) before program implementation. In the event of a delay in this process, the program may be delayed one year from all dates described within.

1.0 PURPOSE OF AND NEED FOR ACTION

1.1 Purpose / Mission of the National Park Service

The overall mission of the NPS is to *preserve resources and serve the public* as mandated by the NPS 1916 Organic Act and presented in the NPS 2000 Strategic Plan (Draft) (USDI NPS 2000) (Appendix I).

In order to enhance the overall mission and give direction to goals, the NPS has prepared guidance documents specifically addressing various issues and management practices. The *Natural Resources Management Guideline - NPS 77* (USDI NPS 1978) provides direction with respect to natural resource management actions, including the restoration of native species (Appendix II).

1.2 Purpose / Mission of the Great Smoky Mountains National Park

The Southern Appalachian National Park Commission described the purpose of the GRSM in the 1924 report submitted to the Secretary of the Interior. GRSM was established *for the benefit and enjoyment of the people*. This purpose was again stated by Congress in the Act of May 22, 1926, which provided for the establishment of the Park. This Act further defined the purpose by reference to the NPS Organic Act of August 35, 1916. The Organic Act stated that the fundamental purpose of national parks is *to conserve the scenery and the natural and historic objectives and the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations*.

The Commission defined its vision of the lands it was seeking for national park designation as follows:

- *Mountain scenery with inspiring perspectives and delightful details.*
- *Areas sufficiently extensive and adaptable so that annually millions of visitors might enjoy the benefits of outdoor life and communion with nature without the confusion of overcrowding.*
- *A substantial part to contain forests, shrubs, and flowers, and mountain streams, with picturesque cascades and waterfall overhung with foliage, all untouched by the hand of man.*
- *Abundant springs and streams available for camps and fishing.*
- *Opportunities for protecting and developing the wildlife of the area, and the whole to be a natural museum, preserving outstanding features of the Southern Appalachians as they appeared in the early pioneer days.*
- *Accessibility by rail and road.*

The 1982 GRSM General Management Plan was prepared for compliance with NPS Management Policy (1998). It reflects a management direction for natural resources to be *managed in accordance with applicable laws and National Park Service Policies* including *the possibility of reintroducing animal species formerly occurring in the park……*

Prior to and since the Park was founded in 1926, several animal introduction / reintroduction actions (direct or indirect) have been implemented / experienced within the current boundaries of the GRSM. These actions had varying degrees of success, failure, and/or impacts. The introduction / reintroduction actions include:

- River Otter (*Lontra canadensis*): Reintroduced in 1986, the otter has successfully established itself throughout the drainage systems within and adjacent to the GRSM.
- Red Wolf (*Canis rufus*): Reintroduced in 1991, the reestablishment failed and the last red wolf was removed from the GRSM in 1998.
- Peregrine Falcon (*Falco peregrinus*): Reintroduced in 1984, the peregrine falcon is successfully reproducing in the GRSM.
- Rainbow Trout (*Oncorhynchus mykiss*): This nonnative species was introduced in the late 1800s for sport fisheries. The rainbow trout is now intensively managed to reduce impact on indigenous fish species.
- Brown Trout (*Salmo trutta*): This nonnative species was introduced in the early 1920s for sport fisheries. The brown trout is now intensively managed to reduce impact on indigenous cold water fish species.
- European Wild Hog (*Sus scrofa*): An exotic species, the European wild hog expanded into the GRSM in the 1950s from early 1900 releases in the Southern Appalachian Mountains. The species is under intense population reduction management.
- Coyote (*Canis latrans*): The coyote has naturally expanded its range during the last 50 years to the Eastern United States. The coyote moved into the Park in the mid-1980s and is now successfully reproducing in the GRSM.
- Smoky Madtom (*Noturus baileyi*): First reintroduced in the mid-1980s with continued establishment ongoing.
- Spotfin Chub (*Hybopsis monacha*): First reintroduced in the mid-1980s with continued establishment ongoing.
- Yellowfin Madtom (*Noturus flavipinnis*): First reintroduced in the mid-1980s with continued establishment ongoing.
- Duskytail Darter (*Etheostoma percurum*): First reintroduced in the mid-1980s with continued establishment ongoing.

1.3 Purpose and Need For Proposed Action

The purpose of the proposed experimental release of elk in the GRSM is to:

- Explore the feasibility of reestablishing a large mammal species documented to have been indigenous to the GRSM before extirpation by European settlers
- Establish a population of free-roaming elk within management parameters according to NPS guidelines.

- Establishment of a large herbivore to aid in natural maintenance of existing early successional openings, natural maintenance newly created openings resulting from natural and managed habitat improvements (i.e. prescribed fire, fallen trees, forest insect and disease outbreaks, etc.) and promotion of natural ecological processes within GRSM.

In support of the proposed action is compliance with the mission of the NPS and GRSM with respect to *maintaining, management, and enhancing natural and cultural resources and associated values by protecting, restoring, and maintaining them in good condition within their broader ecosystem and cultural context.*

1.4 Background

The distribution of the North American elk or wapiti (*Cervus elaphus*) has been significantly reduced since the arrival of Europeans to the North American continent. In particular, the Eastern elk subspecies (*Cervus elaphus canadensis)* and Merriman elk subspecies (*Cervus elaphus merriami*) are thought to be extinct. The Manitoban subspecies (*Cervus elaphus manitobensis)* is represented by a few isolated populations in central Canada (Bryant and Maser 1982) as well as an introduced population at the US Forest Service, Land Between the Lakes in western Kentucky. The Tule elk subspecies (*Cervus elaphus nannodes*) is distributed in four locations in California. The Roosevelt elk subspecies (*Cervus elaphus roosevelti*) is distributed along the Pacific Northwest (California, Oregon, Washington). The most abundant and most distributed elk on the North American continent is the Rocky Mountain elk subspecies (*Cervus elaphus nelsoni*). This subspecies ranges throughout the Rocky Mountains of the United States and Canada. There are introduced populations of Rocky Mountain elk in Texas, Oklahoma, Arkansas, Kansas, North Dakota, Michigan, Pennsylvania, Minnesota, Wisconsin, Kentucky, and Quebec, Canada.

Eastern elk were apparently abundant in the Southern Appalachians prior to European settlement, but their numbers began to decline by the late 1700's due to excessive hunting (Van Doren 1955; Wathen et al. 1996;). The last remaining elk in East Tennessee is thought to have been killed during the mid-1800s (Linzey and Linzey 1971), whereas, the last remaining elk in North Carolina is thought to have been killed during the late 1700s (Linzey 1995).

In keeping with NPS and GRSM policy and natural resource management directives, Park personnel have supported the investigation and explored the possibility of reestablishing elk into the GRSM for over a decade. However, due to a lack of funding, a lack of science-based information to support further consideration of a reintroduction, and projects that demanded a higher priority, release of elk into the GRSM has been delayed.

There has been increasing interest in repatriating elk to the Southeast in recent years, largely due to the conservation efforts of the Rocky Mountain Elk Foundation (RMEF). Recently, wildlife agencies in Kentucky and Arkansas have gone forward with elk reestablishment efforts, while Tennessee, Georgia, North Carolina, and Virginia have evaluated potential elk reestablishment actions. Now, based upon interest of the Park to be responsive to NPS policies, improvement of bio-diversity by establishment of a large herbivore population, potential funding sources, interest of state and local agencies, interest of private organizations, and interest of the population as a

whole, it is has become prudent to develop a plan to support an experimental release effort in the GRSM.

During the last decade, GRSM biologists, supported by a host of national experts on elk and wildlife diseases, have supported, developed, and/or assembled reports and documents that aid in the decision-making process for releasing elk in the GRSM. The most important of these documents include:

- *Feasibility Assessment for the Reintroduction of North American Elk into Great Smoky Mountains National Park* (Long 1996)
- *Elk Reintroduction in Tennessee* (Wathen et al. 1996)
- *Model Health Protocol for Importation of Wild Elk (Cervus elaphus) for Restoration* (Nettles and Corn 1998)
- *Reintroduction Action Plan and Decision Document for Reestablishment of Elk (Cervus elaphus) Into the Great Smoky Mountains National Park* (Flynn et al. 2000)
- *Disease Risk Evaluation for Translocation of Elk From Elk Island National Park / Land Between the Lakes to Great Smoky Mountains National Park* (DeLozier 2000)
- *Policy For Agencies Requesting Elk From Elk Island National Park* (EINP 1999)
- *Ecological Characteristics Of An Elk Reintroduction In Eastern Kentucky – Annual Reports* (KDFWR 2000)

1.5 Regulatory Compliance

This EA has been prepared to comply with:

- National Environmental Policy Act of 1969 (NEPA)
- Council on Environmental Quality (CEQ) Guidelines - 1978 (40 CFR 1500-1508)
- National Park Service (NPS) Guidance Document - NPS-12 (National Environmental Policy Act Guidelines) (USDI NPS 1997)

If selected, implementation of the Preferred Alternative will require compliance with numerous laws, rules / regulations, executive orders, plans, guidance documents, and/or orders (Appendix III). This compliance requirement is dependent upon the location of the source herd and route taken to deliver elk to the Park.

1.6 Decision Process for Selecting Source Elk and Release Location(s) within the GRSM

In order to provide for adequate evaluation of the release effort of elk into the GRSM, Park personnel, supported by a host of wildlife biologists, ecologists, and animal health specialists, developed information to be used in the decision-making process (Appendix IV, Appendix V). This process reviewed and ranked each of the two significant items of the proposed release effort; these are:

- Location / health of the source herd
- Release site / effective use area (EUA) (Defined as 20,000 acres centered around the release site that will include the holding pen).

The results of this evaluation process concluded that the potential source herd locations, listed in random order, are:

- Elk Island National Park - Alberta, Canada
- USFS Land Between The Lakes - Western Kentucky.

The results of this evaluation process concluded that the potential release sites / EUAs, listed in random order, are:

- Bone Valley / Hazel Creek - North Carolina
- Cades Cove - Tennessee (Area excluded for consideration)
- Cataloochee - North Carolina
- Parsons Branch Road - Tennessee
- Mt. Collins - Tennessee & North Carolina.

Further analysis indicated that the USDA Forest Service, Land Between the Lakes - Kentucky is the preferred source of elk and Cades Cove - Tennessee is the preferred EUA for the Phase I release effort.

The ranking process will be used as a guide in selecting the specific source herd and EUA for the experimental program. The experimental program may use both source herd locations and more than one EUA during the five-year experimental program. Due to current management issues (transportation, visitation, etc.) and other planning processes, Cades Cove will not be used as a EUA during the experimental program.

1.7 Stakeholders and Private Citizens Participation

Discussions with the public, interested agencies, and organizations began in March of 2000. Table 3 (Stakeholders and Private Citizens Participation) presents organizations and locations of briefings.

Over 575 stakeholders and private citizens participated in these information sessions. Participants were presented with a history of the decision-making process to conduct the experimental release of elk into the GRSM. The planning team presented information contained in the major documents used to support the decision-making process. Furthermore, the team discussed both the positive and negative impacts that may occur, if the Preferred Alternative were to be implemented.

Comments were noted that presented the opinions of the attendees. Comments were collated and used to develop mitigative actions presented in this document. . Collated comments-of-concern are presented below in the form of questions with brief overall responses:

- Why is GRSM considering reintroducing elk into the Park? (NPS policy and ecological benefits to GRSM.)
- Will there be extensive crop damage? (It is anticipate that damage will be very low.)
- Will there be fence damage? (It is anticipate that damage will be very low.)
- Will farmers be compensated for damage? (No current plan - elk will be managed similar to deer.)
- Will elk introduce new diseases / parasites to native wildlife and domestic animals? (It is anticipate that risks are low.)
- Will existing disease(s) be spread by elk? (It is anticipate that risks are low.)
- Will people be injured from elk / vehicle accidents? (Based upon data from other parks in the United States, it is anticipate the risks are low.)
- Will people be injured from elk / man incidents due to their size? (Based upon data from other parks in the United States, it is anticipate the risks are low.)
- Will elk stay in the Park? (It is anticipate that elk will focus their movements in the Park, however the experimental release will provide the answers we need.)
- Are the elk larger in size than deer? (Yes)
- What are the future management plans for elk in the GRSM? (Unconfirmed at this time. Results of the experimental program should determine if elk can live in GRSM again.)
- Can landowners / farmers protect their property and corps from elk damage without contacting GRSM or wildlife agencies? (Wildlife on state property are under the jurisdiction of state wildlife agency.)
- What is the policy of North Carolina and Tennessee with respect to protecting elk? (States should be contacted for specific policies.)
- How will the GRSM handle elk outside of the Park after the five-year experimental program? (States will determine the disposition of elk on state property.)

These comments-of-concern were used to structure this environmental assessment and formulate mitigative actions for perceived potential impacts.

Overall, comments indicated that the majority of stakeholders and private citizens support the experimental release and reestablishment of elk in the GRSM.

Table 1 Stakeholders and Private Citizens Briefings

DATE	ORGANIZATION	LOCATION	NUMBER OF ATTENDEES
3/04/00	East Tennessee Chapter of the Rocky Mountain Elk Foundation Annual Banquet	Gatlinburg, TN	50
3/07/00	Friends of the Park / Steve Woody	Asheville, NC	2
3/14/00	TN Wildlife Resources Agency / Central Office Staff	Nashville, TN	6
3/15/00	TN Wildlife Resources Agency / East TN Field Biologists and Law Enforcement Staff	Tellico, TN	20
3/21/00	Sevier County, TN, Farm Bureau Board of Directors	Sevierville, TN	25
3/23/00	Smoky Mountain Chapter of the Rocky Mountain Elk Foundation Committee Staff	Asheville, NC	3
3/23/00	USDA Forest Service / NC Forests	Asheville, NC	3
3/27/00	TN Governor's Office / Governor Sundquist	Nashville, TN	4
3/29/00	TN Livestock Association / president, local organizational members and Blount County Agricultural Extension Service	Maryville, TN	10
3/31/00	Great Smoky Mountains National Park personnel	Gatlinburg, TN	7
4/03/00	Blount County, TN, Farm Bureau Board of Directors	Maryville, TN	20
4/04/00	Great Smoky Mountains National Park personnel	Gatlinburg, TN	30
4/04/00	USDA Forest Service / TN Forests	Roan Mt. TN	25
4/05/00	Great Smoky Mountains National Park personnel	Cades Cove, TN	20
4/07/00	Great Smoky Mountains National Park personnel	Cherokee, NC	15
4/07/00	USDI Fish and Wildlife Service	Asheville, NC	4
4/10/00	NC Wildlife Resources Commission Central and Regional Staff	Raleigh, NC	9
4/14/00	American Association of Laboratory Research Society Conference	Knoxville, TN	45
4/17/00	Haywood County, NC, Farm Bureau Board of Directors	Waynesville, NC	13
4/19/00	Congressman Charles Taylor's office, NC Livestock Association, NC State Department of Agriculture, Haywood County Agriculture Extension Service, NC Farm Bureau, local livestock and farm bureau members	Waynesville, NC	30
4/20/00	Great Smoky Mountains National Park staff	Gatlinburg, TN	20
4/21/00	TN Great Smoky Mountains Park Commission	Gatlinburg, TN	10
4/27/00	Cocke County, TN, Farm Bureau Board of Directors	Newport, TN	15
4/29/00	Great Smoky Mountains National Park Friends of the Park Board of Directors	Maggie Valley, NC	25
5/06/00	Natural History Association Members	Gatlinburg, TN	20
5/09/00	Sevierville, TN, Rotary Club	Sevierville, TN	45
5/10/00	Eastern Band of the Cherokee Indians	Cherokee, NC	5
5/11/00	TN Wildlife Resources Agency Sevier and Blount County wildlife officers, Townsend Police Department	Townsend, TN	6
5/17/00	Sevier County, TN, County Leadership Group	Gatlinburg, TN	35
5/23/00	Haywood County, NC, Public Meeting	Sylva, NC	20
5/31/00	Henderson County, NC, Public Meeting	Asheville, NC	35

2.0 DESCRIPTION OF ALTERNATIVES

Two alternatives are presented as reasonable actions to address the experimental release of elk into the GRSM. These alternatives are:

- Alternative A: No Action
- Alternative B: Experimental Release of Elk into the GRSM.

Each of these alternatives is presented below.

2.1 Alternative A: No Action (Null Alternative)

Alternative A, although feasible, is contrary to the mission, directives, guidance, and management policies of the NPS and the GRSM with respect to reintroduction and management of extirpated species.

Selection of Alternative A would result in elk not being reestablished into the GRSM and the natural resources management actions of the GRSM remaining unchanged.

Selection of Alternative A would also result in no direct or cumulative impact to the affective environment of the Park or surrounding properties. Positive impacts that would not occur include:

- Maintenance of existing openings / diverse habitat
- Creation of new openings / diverse habitat
- Restoration of natural processes
- Improvement of biodiversity
- Enhancement of wildlife viewing.

2.2 Alternative B: Experimental Release of Elk into the GRSM

Alternative B (Preferred Alternative) proposes the experimental release of elk into the GRSM via a controlled soft release of 75-90 elk over a three-year period (2001 - 2003).

Although a habitat assessment has been performed in the GRSM (Long 1996), the only way to objectively determine if repatriating elk to GRSM and the Southern Appalachian Mountains is feasible is through an experimental release program. If it is determined that elk repatriation is biologically feasible, Park managers can then determine whether such repatriation is desirable. At that time, protocols for elk population reestablishment at GRSM will be developed.

Objectives of experimental release are to:

- Determine dispersal and mortality rates of reintroduced elk
- Determine whether mortality or post-release movements vary by age, sex, or reproductive status
- Assess habitat use and compare with Long's (1996) findings
- Evaluate the effects of variable acorn production on elk demography

- Evaluate impacts of elk reintroduction (native vegetation, wildlife, agricultural crops, fence damage, highway mortality, safety)
- Assess the feasibility, methodology, approach, and probability of success of releasing elk to establish a permanent, viable population at GRSM

If selected, the proposed action will be implemented in three phases:

- Phase I – Experimental Release and Data Collection – The experimental release will be a controlled soft release of 75-90 elk over a three-year period (2001-2003) and data collection through 2004. Monitoring will continue through 2005.

  The soft release will require construction of a holding pen of woven fencing and wooden slats. Elk will be released into the holding pens, fed, treated, and observed up to 90 days prior to release. The holding pens will remain throughout Phase I.

  Data, to include, mortality / natality rates, mortality causes, movement patterns, habitat preference, food preference, predator impact, observations, visitor outdoor experience enhancement, habitat damage, crop damage, human / elk interaction, etc., will be collected over a four-year period (2001-2004).

- Phase II – Data Evaluation – Evaluation of data by University of Tennessee and GRSM biologists will actually begin before the completion of Phase I. Phase II is scheduled to be completed upon completion of Phase I.

- Phase III – Elk Management - Phase III will implement one of the following two actions:

  1) Evaluation of an elk reestablishment program to include a long-term management plan
  2) Remove of elk from the GRSM ecosystem [2006 +].

Phase I and II will be conducted / supported by:

- Great Smoky Mountains National Park
- Rocky Mountain Elk Foundation
- Friends of Great Smoky Mountains National Park
- Eastern Band of Cherokee Indians
- US Geological Survey, Southern Appalachian Field Laboratory, Biological Resources Division (USGS BRD)
- The University of Tennessee (UT), Department of Forestry, Wildlife, and Fisheries.

USGS BRD and UT will take the research lead (Phase I and II). Phase III will be conducted by the GRSM. The RMEF, Friends of the Great Smoky Mountains National Park, Great Smoky Mountains Natural History Association, and Eastern Band of Cherokee Indians will support all three phases.

3.0 THE AFFECTED ENVIRONMENT

3.1 Affected Environment of the GRSM

The GRSM consist of 523,000 acres that straddle the Eastern Tennessee / Western North Carolina common border. The Park is composed of 15 vegetation types influenced primarily by gradients of moisture and elevation (Whittaker 1956). Elevation in the Park ranges from 840 feet mean sea level (MSL) at the mouth of Abrams Creek to 6,643 feet MSL at the top of Clingmans Dome.

Area surrounding the Park is comprised of two national parkways, three national forests, a Cherokee Indian reservation, an extensive system of lakes developed by the Tennessee Valley Authority (TVA) and the Aluminum Company of America (ALCOA), and land belonging to private individuals / organizations.

The GRSM is part of the large Appalachian Mountain system, which consists of a series of mountain ridges trending northeast to southwest from Maine to Georgia. The Unaka Range, a major unit of the Appalachians encompassing the mountains of the Park, lies wholly within the Mississippi River drainage. The Unaka Range is cut into segments by northwesterly flowing tributaries of the Tennessee River. The Pigeon River cuts the main ridge of the Unakas on the northeast and the Little Tennessee cuts the main ridge of the Unakas on the southwest (USDI NPS 1982)

The mountain remnants seen today are principally the result of stream erosion. The dominant topographic feature of the Park is the northeastward-trending ridgeline that forms the boundary between North Carolina and Tennessee. For 36 of its 71 miles, the main divide stands more than 5,000 feet above sea level. Lower ridges form radiating spurs from the central ridgeline. The moderately sharp-crested, steep-sided ridges are separated by deep valleys that occasionally widen along the sides of higher ridges. Many of the ridges branch and subdivide, creating complex drainage systems that abound with fast-flowing mountain streams (USDI NPS 1982).

3.1.1 Water Resources

The Park is located in one of the highest precipitation regions of the United States averaging 64 inches annually. This rainfall equates to some 890 billion gallons of which 500 billion gallons are discharged as runoff by the many streams that drain the Park (USDI NPS 1983).

<u>Surface Water</u>

All streams within the Park are small with none draining more than 200 square miles. There are 333 streams (+/- 1,000 miles) in the Park large enough to be classified as fishable. The average drop for each mile of stream channel is 400 feet. Headwater slopes are steep, increasing as much as 2,000 feet per mile.

Surface water quality in the Park is considered good but slightly acidic (pH range from 5.9 to 7.5) and low in dissolved solids. Exceptions to this are streams associated with the Anakeesta

geologic formation, which have a pH of about 4.5. The streams have a low natural buffering capacity and are therefore sensitive to acid precipitation. Surface water is clear during normal and low flow but turbid during storm events. Historically, water samples from most of the Park streams indicate a low level of coliform bacteria indicating the presence of organic matter and possibly fecal contamination.

Groundwater

The best sources of groundwater are from among the thick layers of weathered material overlying highly fractured bedrock. The best locations include the floors of valleys and gentle slopes surrounding the valleys. Water yields from wells in the Park vary from less than one gallon per minute to over 135 gallons per minute. Groundwater quality is similar to surface water in that it is low in dissolved solids and slightly acidic (USDI NPS 1983).

3.1.2 Geology / Soils

Geology

The geology of the GRSM is complex. Some of the rocks exceed 1 billion years in age. Almost all exceed one-third of a billion years in age. The geology has been greatly affected by weathering, metamorphism, folding, and faulting (USDI NPS 1983).

The geologic formations of the Park can be divided into three groups:

- Metamorphic Rocks: Metamorphic rocks of the Precambrian basement complex (> 1 billion years) form the ancient crystalline foundation on which all the other strata of the region have been laid. The complex consists of a wide variety of gneisses and schists.

- Sedimentary Rocks: Sedimentary rocks of the late Precambrian Ocoee series (600 million to 1 billion years old) are predominant in the Park. The rocks vary in degree of metamorphism from hard, intensely metamorphosed phyllites and schists in the southeast to less altered, weaker rocks (shale and slate) in the northwest. The Anakeesta formation of this group produces acid runoff containing concentrations of heavy metals (zinc, manganese, copper, iron, and cobalt) and aluminum when exposed to water and air.

- Sedimentary Rocks: Sedimentary rocks of the Appalachian Valley were deposited during the Paleozoic era (300 million to 600 million years old). Rocks of this group found in and around the Park include limestone, dolomites, and quartzites (USDI, Geological Survey 1968).

Soils

Erosion has been very important in shaping the topography of the GRSM. Valley bottoms have become collection points for eroded soils, which are well drained and of high quality. The parent materials of the primary soils are the noncalcareous shales, quartzites, and sandstones of the Ocoee series. Soils in the Park are found in six associations. These are:

- Jeffrey-Brookshire-Ditney Association: This association is found above 3,000 feet elevation along the main northeast – southwest ridgeline and is underlain mainly by coarse-grained rocks. Depth to bedrock ranges from a few inches on sharp crests to six or seven feet near the bases of long slopes

- Sylco-Ranger-Cataska Association: This association is generally at elevations between 1,500 and 3,500 feet along the perimeter from Twenty Mile Creek in the southwest to Little Cataloochee in the northeast. These soils are mostly slaty silt loam. Depth to bedrock ranges from five to six feet at the bases of long, steep slopes to less than one foot at higher elevations.

- Allen-Jefferson Association: This association can be found in the Cades Cove and Indian Camp Creek areas. Rolling and hilly, these soils are well drained and deep. The association has loam surface layers up to 10 inches thick and permeable clay loam subsoils several feet thick.

- Sylco-Telladega Association: This association is found at lower elevations of the southwestern part of the Park – east of Twenty-Mile Creek, west of Bryson City, and north of Fontana Lake. The soil is underlain by phyllite shales and slate rock with a silt loam surface layer about five inches thick and clay loam subsoils one to two feet thick. Depth to bedrock is from one to four feet.

- Evard-Saluda Association: This association is found northeast of Bryson City to the Cherokee Indian Reservation. This soil was formed from gneiss and schist rocks weathered to depths of five to 20 feet. Surface layers are brown or sandy loams and subsoils are reddish clay loams that are moderately permeable. These soils form on steep mountains with fairly narrow ridgetops and with sides highly dissected by drainage ways.

- Porters-Edneyville-Ashe Association: This soil association is found in the southeastern corner of the Park on steep mountains, generally above 3,500 feet in elevation. The soils have been formed from weathering of granite and gneiss rocks, which become hard at two to five feet below the surface. The surface layer is dark brown or sandy loam and the subsoil is yellowish-brown clay loam. They have moderately rapid permeability.

3.1.3 Vegetation

The forests of the GRSM have been described as the most complex and diverse in North America. Due to its topographical relief, complex soils, and position in the continent, the GRSM supports an enormous diversity of vegetation. Almost 95 percent of the Park is forested. The Park has more vascular plant species than any other unit in the national park system, and the number of nonvascular plant species ranks among the highest of any area in North America north of Mexico (Rock and Langdon 1991). More than 1,600 species of vascular plants have been identified in the Park (including over 100 native tree species), 10 percent of which are considered rare. Of the 1,600 species of vascular plants, over 350 are nonnative. More than 4,000

nonflowering plant species are present, including species of mosses and liverworts, 2,250 species of fungi, and 302 species of lichens. About 10 plant taxa, new to the Park, are discovered each year.

Approximately 160,000 to 200,000 acres of old-growth forest are found in the Park of which about 100,000 acres are considered virgin forest. This is one of the largest blocks of virgin temperate deciduous forest in North America.

Whittaker (1956) identified 15 vegetation types along complex gradients of moisture and elevation. However, eight vegetation types are considered dominant; these are:

- Pastures and cultivated fields
- Heath and grassy balds (above 4,000 feet in elevation)
- Spruce / fir forest (above 4,500 feet in elevation)
- Northern hardwood forest (3,500 to 5,000 feet in elevation)
- Cove hardwood forest (below 4,500 feet in elevation)
- Hemlock forest (3,500 to 4,000 feet in elevation)
- Closed oak forest (predominantly below 4,500 feet in elevation)
- Open pine / oak forest (found along dry ridges)

3.1.4 Wildlife

The GRSM contains a diverse number of wildlife species due to the Park's size, topography, vegetation, and human land uses. More than 60 native mammal species are know to occur in the Park, half of which are rodents. More than 240 species of birds use the Park. Thirty-six reptilian species have been identified.

The Park's heavy precipitation and numerous streams support a very diverse amphibian population. Forty-four amphibian species occur in the GRSM, including 29 salamander species (the most diverse salamander population anywhere in the world). Three toad species and nine frog species have also been identified. Fifty-eight species of freshwater fish inhabit the streams of the region, although several of these species are nonnative. Ninety-five known species of land snails, insects, and spiders are also found in the Park.

3.1.5 Threatened and Endangered Species

Plants

There are five plants indigenous to the GRSM and adjacent lands listed under the authority of the Endangered Species Act of 1973 as federally endangered or threatened; these are:

- Rock Gnome Lichen (*Gymnoderma lineare*) Endangered
- Spreading Avens (*Geum radiatum*) Endangered
- Virginia Spiraea (*Spiraea virginiana*) Threatened
- Small-Whorled Pogonia (*Isotria medeoloides*) Threatened

Animals

There are 20 animals (vertebrates and invertebrates) indigenous to the GRSM and adjacent lands listed under the authority of the Endangered Species Act of 1973 as federally endangered or threatened; these are:

- Red-Cockaded Woodpecker (*Picoides borealus*) Endangered
- Smoky Madtom (*Noturus baileyi*) Endangered
- Indiana Bat (*Myotis sodalis*) Endangered
- Northern Flying Squirrel (*Glaucomys sabrinus coloratus)* Endangered
- Panther (Mountain Lion) (*Felis concolor*) Endangered
- Gray Bat (*Myotis grisescens*) Endangered
- Appalachian Elktoe (*Alasmidonta raveneliana*) Endangered
- North Carolina Funnelweb Tarantula (*Microhexura montivaga*) Endangered
- Oyster Mussel (*Epioblasma capsaeformis*) Endangered
- Fine-rayed Pigtoe (*Fusconaia cuneolus*) Endangered
- Green-blossom Pearly Mussel (*Epioblasma torulosa gubernaculum*) Endangered
- Little-wing Pearly Mussel (*Pegias fabula*) Endangered
- Dusky Darter (*Ethestoma percurum*) Endangered
- Bald Eagle (*Haliaeetus leucocephalus*) Threatened
- Spotfin Chub (*Hybopsis monacha*) Threatened
- Yellowfin Madtom (*Noturus flavipinnis*) Threatened
- Bog Turtle (*Clemmys muhlenbergii*) Threatened
- Snail Darter (*Percina tanasi*) Threatened
- Noonday Globe (*Patera clarki nantahala*) Threatened

Other plant and animal species are listed "in need of management" and "under consideration for listing". These species will be given the utmost attention and special consideration during the experimental program.

In addition to the federally listed species, the GRSM maintains a database of 320 plant and animal species listed by the states of North Carolina and Tennessee. Management of these plant and animal species will be according to the guidance established by the respective state.

3.1.6 Cultural Resources

Humans have been a part of the Southern Appalachian ecosystem for the past 15,000 years (USDI NPS 1983). Cherokee Indians occupied the mountains and the adjoining lowlands before white European settlers forced them out in the 1800s. Prehistorical and historical chronologically recognized periods include:

- *Paleo-Indians:* > 15,000 years ago - Nomadic hunters from the Great Plains

- *Archaic Culture:* 7,000 B.C. - Paleo-Indian culture evolved into the Archaic Culture (hunters and gatherers)
- *Woodland Period:* 1,000 B.C. – Predominantly agriculture society
- *Mississippian Culture:* A.D. 900 – Overlapped with Woodland Period but noted for villages with large central ceremonial mounds, temples, and plazas.
- *European Contact:* 1566 or 1567 – First contact. By 1700 Cherokees were using European goods arriving from the eastern seaboard.
- *European Settlement:* 1760 – Intensive settlement by European settlers
- *Cession of the Majority of Cherokee Homeland:* Early 1880s. By the beginning of the Civil War all of the conveniently arable land of the region had been occupied by European settlers.
- *Development:* Commercial logging began about 1880. Due to its isolation, common knowledge about the Great Smoky Mountains area dates primarily from the 20th century.

The Cultural Resources Branch of the GRSM focuses on the period from the middle 1800s to 1920. Interpretation is based on structures remaining in the Park, on tools and home furnishings recovered from those who once lived there, as well as on many interviews with and studies of mountain people of the area prior to the formation of the Park.

About 1200 structures dating from the middle 1800s to 1920 were scattered through the Park when it was first established. At present 187 historic structures, including a prized collection of pioneer log structures, remain in GRSM. Of those, 128 historic structures have been placed on the National Register as defined by the National Historic Preservation Act of 1966.

The Park contains 118 known archeological sites and four cultural landscapes. Approximately 132 cemeteries are also found in the Park and are maintained for freedom of access and upkeep by the GRSM.

3.1.7 Air Quality

Research and monitoring conducted at GRSM have shown that airborne pollutants are significantly damaging Park resources and visitor enjoyment. The burning of fossil fuels – coal, oil, and gas – by power plants, motor vehicles, and factories in the eastern United States, cause most of the pollution. Air quality over the past decade has been deteriorating at the Park.

Under the Clean Air Act, the Park is designated a Class I area worthy of the greatest degree of air quality protection under the Act. The Act directs the Federal Land Manager to protect the air quality related values and assume an aggressive role in protecting and enhancing the air quality…erring on the side of protection for future generations.

Visibility has been seriously degraded over the past 50 years. Visibility has declined 80 percent in summer and 40 percent in winter, since 1948. Sulfate particles scatter light and degrade

visibility and account for 73 percent of the summer haze. Summer sulfate concentrations have increase 27 percent from 1984-1999.

Acid deposition has significantly impacted park streams and soils. The Park receives the highest amounts of nitrogen and sulfur deposits of any monitored national park in the United States. Certain high elevation soils are receiving so much nitrogen that they are suffering from advanced nitrogen saturation. This condition limits forest nutrients to plants and animals and causes the release of toxic aluminum that can harm vegetation and stream life. Nitrate deposition at the Park has increased 26% from 1981-1998.

Ozone pollution affects breathing in people and damages vegetation. Ozone exposures in the Park are among the highest in the eastern United States and have exceeded public health standards. In 1998, there were 44 unhealthy days, and in 1999, there were a record 52 unhealthy days. Ozone also affects vegetation. There are 30 species of plants that show visible leaf damage from ozone and certain species, like black cherry (*Prunus serotina*) and yellow poplar (*Liriodendon tulipifera*), show growth reductions from ozone (Renfro, personal communication 2000).

3.1.8 Sound Quality

Sound quality in the Park is considered high and is composed primarily of wind in trees, cascading streams, rain, thunderstorms, birds, insects, and animals. Other sounds include automobile noise near highways; human activity sounds near campgrounds, picnic areas, visitor centers, and other public areas; and an occasional low-flying aircraft.

3.1.9 Visual Quality

The GRSM is noted for its outstanding vistas. These vistas include:

- Forest resources
- Mountain streams
- Wildlife
- Flowering plants
- Historical resources
- Scenic roads
- Scenic trails

3.1.10 Socioeconomics

The broad management goals of the Park are to preserve the Park's diverse resources while providing for public benefit and enjoyment. GRSM is the most heavily visited park of the national park system, drawing over 10 million visitors annually (10,283,600 for 1999). Most visitors to the region travel in private automobiles. In addition to roads providing access to and within the Park, numerous foot and horse trails provide access to the Park's backcountry. The principal use of GRSM is recreational. Activities include viewing wildlife and scenery from

motor vehicles, hiking, biking, camping, horseback riding, kayaking, and fishing. Hunting is not allowed within GRSM, but bear, deer, and smaller game species are hunted outside its boundaries on both national forest and private land.

Park visitation rates vary seasonally, peaking between June and October (USDI, NPS, GRSM 2000). Visitation tends to be heavier during weekends and holidays, and backcountry use is high during college breaks. The Park's natural features are the main attraction for visitors, with most activities restricted to driving through the Park, or picnicking, rather than backcountry camping and hiking.

The Park's backcountry contains approximately 850 miles of trail with 102 campsites and 18 shelters. While hundreds of thousands of people came to the Smokies in 1999, it is evident that larger numbers do not spend their time camping. When compared to 1998, a 2 percent decline was recorded at the front country campgrounds. Camper nights numbered 350,589 at the 10 developed campgrounds, just under the 357,623 that was reported in 1998. Just about the same number of campers utilized the 102 backcountry campsites registering 92,994 in 1999 compared to 92,522 in 1998. Additionally, data collected suggest there are over 80,000 private horse rides and 450,000 day hikes annually (USDI NPS GRSM 2000, USDI NPS 1983).

The GRSM has an annual budget of $13.2 million and provides an economic hub generating over $1 billion a year for surrounding tourist communities (USDI NPS GRSM 2000).

3.2 Affected Environment of Adjacent Lands / People

Eight counties encompass or lie close to boundaries of GRSM: Blount, Sevier, Cocke and Monroe counties in Tennessee are situated on the northern end, and Graham, Jackson, Swain and Haywood counties in North Carolina occupy the southern vicinity of the Park. Land surrounding the Park is mostly rural, consisting primarily of forested foothills and mountains. Approximately 84 percent of the land within a six-mile radius of the GRSM boundary is forested. The remaining areas, consisting mostly of agricultural land (10 percent) and urban development (2 percent) are potential zones for elk-human conflict.

Area surrounding the Park is comprised of two national parkways, three national forests, a Cherokee Indian reservation, an extensive system of lakes developed by TVA and ALCOA, and land belonging to private individuals / organizations.

Small towns and communities, some adjacent to the Park, are scattered throughout the region. The mean human population density of the eight county region is +/- 80 individuals / square mile. The majority of the people in the eight county region are employed in retail trade, manufacture, and services. Much of the economy is tourism-related and land traditionally used for forests and agriculture is increasingly being replaced by resort communities, vacation homes, and retail business.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Environmental Consequences of Proposed Alternatives

One or more of the following terms may have been used to discuss environmental consequences:

- Negligible Impact: An impact with a low level of detection
- Minor Impact: A slight, but detectable impact
- Moderate Impact: An impact which is readily apparent
- Major Impact: An severe adverse impact or exceptionally beneficial impact
- Short Term Impact: An impact directly associated with actions
- Long Term Impact: An impact beyond associated actions
- Cumulative Impact: An impact from non-project actions affecting the same resource
- Positive Impact: An impact that enhances the environment
- Nonsignificant Impact: Any of the previous impacts that can be mitigated prior to or during implementation of the proposed action
- Significant Impact: An impacts that is beyond mitigation at the environmental assessment (EA) level

4.1.1 Alternative A: No Action

Analysis: The No Action Alternative would not allow the GRSM to meet the objectives and guidance established by the NPS with respect to ensuring that natural and cultural resources and associated values are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.

Furthermore, potential beneficial impacts would not occur; examples of these are:

- Maintenance of existing openings / diverse habitat
- Creation of new openings / diverse habitat
- Restoration of natural processes
- Improvement of biodiversity
- Enhancement of wildlife viewing.

Conclusion: The No Action Alternative would result in the ecosystem of the Park remaining unaffected. However, the Park would continue to function but without an important extirpated indigenous species.

4.1.2 Alternative B: Experimental Release of Elk into the GRSM – Preferred Alternative

4.1.2.1 Impacts to the Human Environment

Potential impacts to the human environment consist of potential impacts to private property / real estate; transmission of diseases to livestock, wildlife, and humans; public safety; and socioeconomics. These impacts are discussed in detail in the following paragraphs.

4.1.2.1.1 Impacts to Private Property / Real Estate

Analysis: Elk reintroduction efforts at other locations have documented movement of elk up to 100 miles from the release site (KDFWR 2000). However, excessive post-release movement of elk is usually restricted to a few animals of which the majority is bulls. The Kentucky Department of Fish and Wildlife has released over 800 elk in Eastern Kentucky (1997 - 2000) and has experienced excessive movement from only one bull out of the 800 elk released. Generally movement has been within 15 miles from the hard-release (no acclimation) site but has ranged from 0 - 100 miles (KDFWR 2000).

Documented damage to private property includes fences, farm crops, orchards, golf courses, landscaping, and vegetable gardens. The severity of damage depends upon the length of time elk remain in the specific area. Mitigation measures to limit impacts are the implementation of a harassment action that motivates elk to leave the area and/or to remove elk from the area. Mitigation of damage to personal property of GRSM visitors will be according to current NPS policy and procedures. Mitigation of damage to personal property and/or real estate outside of Park boundaries will be according to state of Tennessee and North Carolina rules and regulations addressing damage by wildlife.

If elk move outside the boundaries of the GRSM, the potential for real estate damage to adjacent privately owned lands does exist. Recognizing the potential for private property / real estate damage, the GRSM has been cooperatively working with the following agencies to establish a plan for managing elk movement outside of Park boundaries during the experimental program (2001 - 2005); these agencies are:

- Tennessee Wildlife Resources Agency (TWRA)
- North Carolina Wildlife Resources Commission (NCWRC)
- United States Fish and Wildlife Service
- United States Forest Service (USFS)
- Eastern Band of the Cherokee Indians
- Local agricultural interest groups

The management plan for areas outside of the Park boundary is termed "Zone Management" (Figure 1 - Elk Management Zones) and is similar to the approach utilized by the State of Kentucky to manage elk that stray outside the established core area for elk in Eastern Kentucky.

The Zone Management approach delineates areas adjacent to the GRSM into two categories; these are:

- Buffer Zone
- No Elk Zone

Areas delineated within the "Buffer Zone" are directly adjacent to the Park boundary and expand to a predetermined location. Here, elk will be permitted unless significant conflicts or incidents are documented. If a significant conflict occurs, GRSM, in cooperation with Tennessee Wildlife Resources Agency (TWRA), North Carolina Wildlife Resources Commission (NCWRC), Eastern Band of the Cherokee Indians, and United States Forest Service biologists will remove elk related to the incident. Areas outside the "Buffer Zone" will be designated as "No Elk Zones". All elk that enter these area will be removed.

Sensitive sites within the "Buffer Zone" will be noted as "No Elk Zones". Sensitive sites could include farm crops, known sites of T&E species, orchards, urban areas, golf courses, etc. Residents within the "Buffer Zone" can request additional sensitive sites be considered for inclusion into the "No Elk Zone" if significant conflicts occurs.

The GRSM, in corporation with the TWRA, NCWRC, USFS, and the Eastern Band of the Cherokee Indians will be responsible for management of elk outside of the Park during the experimental phase. Should completion of the experimental program in 2005 determine that elk could sustain themselves in Southeast forest, management of elk outside of the GRSM boundaries will be the responsibility of the adjacent, respective state wildlife management agency.

Conclusion: The management of elk utilizing a "Zone Management" approach could result in minor impacts to private property / real estate during the experimental program. In relation to the total project, these impacts are considered to be nonsignificant.

4.1.2.1.2 Diseases or Disease Agents

Analysis: GRSM personnel have sought information on known diseases and parasites that afflict elk from the Southeastern Cooperative Wildlife Disease Study (SCWDS). The SCWDS composed a literature review of known diseases and parasites not only in the United States but worldwide that have been documented to afflict all subspecies of red deer (elk) including indigenous, introduced, and farmed populations. Following is a list of significant diseases and parasites that were identified by the SCWDS:

- Chronic Wasting Disease (CWD)
- Bovine Brucellosis
- Bovine Tuberculosis (TB)
- Paratuberculosis
- *Elaphostrongylus cervi*
- Septicemic pasteurellosis

Appendix VI presents a discussion of each of these diseases.

Figure 1 Elk Management Zones

See attached file http://www.nps.gov/grsm/gsmsite/elkmap.pdf

GRSM recognizes the severity of CWD, bovine brucellosis, TB, *Elaphostrongylus cervi*, and septicemic pasteurellosis in cervids and established exclusionary criteria for source elk during the decision-making process of the proposed experimental program. If the Preferred Alternative is selected, source animals will not be acquired from:

- Elk herds with no established disease monitoring program
- Elk herds from areas known to have documented evidence of CWD
- Elk herds with current evidence of brucellosis
- Elk herds with current evidence of TB
- Farmed elk herds from Canada or the United States
- Elk herds from areas known to have documented evidence of septicemic pasteurellosis

Paratuberculosis is endemic in cattle in the Southeast, but there is no evidence that the abundant white-tailed deer, which are susceptible to infection, are serving as an epidemiologic factor at present in the region. The same statement can be made for elk in the western United States (Nettles and Corn 1998). Since this disease is endemic in cattle in the Southeast, exclusionary criteria were not developed that prevent the source herd from having a history of testing for this disease.

Parasites that are harbored by elk and worthy of mentioning include:

- *Echinococcus granulosis* (a species of tapeworm)
- Giant liver fluke (*Fascioloides magna*)
- Nonendemic species of ticks (*Dermacentor andersonii* and *Ixodes pacificus*)
- Mites (*Psoroptes*).

The Risk Assessment (2000) prepared by the GRSM has determined that the potential health consequences of introducing elk infected with *E. granulosis* are low to none resulting in an overall current risk assignment of "Low".

The GRSM will implement the following actions to reduce the risk of source elk carrying the giant liver fluke:

- Utilize elk only from the southern part of EINP, where the presence of live giant liver flukes has never been documented
- Utilize elk from the USFS LBL where giant liver flukes (live) have never been documented
- Treat each elk for giant liver flukes twice with Triclabendazole at the source location
- Treat each elk for giant liver flukes once with Triclabendazole upon arrival at the GRSM prior to release
- Remove vegetation from the perimeter of the holding area to reduce the likelihood of ingress of snails that are necessary to transmit parasites between animals.

Elk will be visually screened for *Dermacentor andersonii* and *Ixodes pacificus* and/or symptoms of ticks. Treatment at the source location for external parasites will be the use of injectable Ivermectin, Coumaphos, and/or Permethrin. Elk will also be treated with these insecticides prior to release into the EUA at GRSM.

Source elk will be inspected and treated at the source location for signs of hair loss and lesions from mites of the family Psoroptidae. Those found to have unexplained hair loss and lesions will not be accepted and returned to the donating agency. Each elk accepted by GRSM will be treated at the source location with injectable Ivermectin. Each elk will also be treated with injectable Ivermectin prior to release into the EUA at GRSM.

Conclusion: The GRSM has developed a list of exclusionary criteria that will prevent diseased animals from being used for Preferred Alternative actions. Furthermore, the Park will implement a screening, inoculation, and treatment program on all elk used for the Preferred Alternative. Inoculation and treatment will be implemented at the source location and again at the GRSM prior to release into the EUA. The exclusionary criteria, inspection, and treatment / inoculation procedures far exceed any requirements / procedures conducted by the livestock industry for transportation of livestock inter- or intra-state. Therefore, the impact from introducing diseases / disease agents can be mitigated and is considered nonsignificant.

4.1.2.1.3 Safety Issues

***Analysis*:** Reintroduction of elk could result in impacts to Park visitors through elk-vehicle collisions and/or direct contact. Currently, the GRSM documents up to 10 deer-vehicle incidents per year. In the near term it is expected that elk-vehicle incidents would not reach the deer-vehicle number of incidents due to the low density of elk verses the current deer speed limits inside the Park range from five to 45 miles per hour. These controlled and slower vehicle speeds should greatly limit the occurrence and severity of vehicle collisions and damage.

Elk are prevalent throughout western national parks, national forests, and BLM properties. Furthermore, reintroduced populations in Kansas, Arkansas, Kentucky, Pennsylvania, Minnesota, and Wisconsin are located on both public and private properties. Table 4 (Personal Property Damage or Injury from Elk in National Parks of the United States Within the Last Few Years) presents man / elk incidents in NPS parks that depict safety issues of concern.

Although elk have been documented to exhibit aggression toward predators, elk are generally timid in the presence of humans and will tend to move away when humans approach them. However, certain situations do exists (i.e. Yellowstone NP, artificial feeding, etc.) where elk have become habituated to the presence of humans and/or food-conditioned to unnatural foods.

In order to reduce the potential of elk incidents during the experimental program, the GRSM will publish literature advisories for Park visitors documenting dangers associate with harassment and contact with elk. If necessary, educational signs will be posted in areas of elk use. Finally, status updates for the elk experimental program will be provided to visitors and Park personnel.

Furthermore, elk exhibiting abnormal or aggressive behavior will be evaluated for possible implementation of appropriate management actions.

Table 2 Personal Property Damage or Injury from Elk in National Parks of the United States Within the Last Few Years

Location	Personal Property Damage / Injury		
	Vehicle	Injury	Total
Yellowstone National Park	1	1	2
Glacier National Park	0	0	0
Rocky Mountain National Park	Few*	0	Few
Bandelier National Monument	0	0	0
Olympic National Park	0	0	0
Redwood National Park	0	2	2
Theodore Roosevelt National Park	0	0	0
Grand Teton National Park	0	0	0
Buffalo National River	0	0	0
Wind Cave National Park	1	0	1
North Cascades National Park	0	0	0

* Incidents known to have occurred but records not maintained.

Conclusion: The impact to personal property damage or injury from elk has been determined to be minor during the experimental program and therefore, nonsignificant.

4.1.2.1.4 Socioeconomics

Analysis: As the highest visited of the 54 national parks, the GRSM provides an economic hub generating over $1 billion a year for surrounding tourist communities (USDI NPS GRSM 2000). Elk viewing in western states and eastern states that have reintroduced elk has proven to be of major economic benefit. Western areas, such as the National Elk Refuge in Jackson Hole, Wyoming, attribute millions of dollars annually to the local economy through elk viewing. With only three years into an elk reintroduction program, the State of Kentucky estimates that elk viewing has brought millions of dollars annually to the counties in which elk have been released. Pennsylvania estimates that hunting and viewing of elk add over $24 million to the local and state economy.

Conclusion: The impact to socioeconomics from the Preferred Alternative has been determined to be a minor impact to the Park due to the possibility increased vehicle traffic near

viewing areas and a positive economic impact to surrounding counties in Tennessee and North Carolina, but of unknown dimension.

4.1.2.2 Natural Resources Impacts – GRSM

4.1.2.2.1 Water Resources

Analysis: The GRSM has over 2,000 miles of perennial streams. Surface water quality in these streams is considered good but slightly acidic (pH range from 5.9 to 7.5) and low in dissolved solids. The surface water is clear during normal and low flow but turbid during storm events. Historically, surface water samples from most of the Park streams indicate a low level of coliform bacteria indicating the presence of organic matter and possibly fecal contamination.

Elk trails, wallows, and bedding areas can contribute soil erosion to surface streams. However, this contribution will be localized and probably not measurable. Since the streams already have coliform bacteria and fecal contamination from other wildlife (USDI NPS 1983), the addition of elk waste should not substantially create further stream degradation.

Since elk will have no direct contact with groundwater, no impact is perceived.

Conclusion: The impact to water resources has been determined to be negligible to nonexistent, and therefore, nonsignificant.

4.1.2.2.2 Geology / Soils:

Analysis: Elk will have no impact on the geology of the Park. Soils will be impacted from trails, bedding areas, and wallows; however, this impact will be localized and should not create erosion actions that would significantly impact the overall ecology of the Park.

Conclusion: The impact to geology / soils has been determined to be nonsignificant.

4.1.2.2.3 Vegetation

Analysis: GRSM vegetation is composed of more than 1,600 species of vascular plants and more than 4,000 nonflowering plant species, including 467 species of mosses and liverworts, 2,250 species of fungi, and 393 species of lichens (USDI NPS GRSM 2000). Park vegetation will be utilized by elk for food and cover. A habitat analysis of the Park conducted by Long (1996) suggests that there is sufficient vegetation to provide an adequate food source and cover for elk without impacting vegetation for other wildlife users or destroying habitat. In fact, elk studies in other national parks have suggested that by the utilization of vegetation species to the extent that vegetation succession is maintained (D. Houston, personal communication 1999). In the GRSM, it is believed that the elk could be beneficial to maintaining the high elevation grassy balds thus decreasing the need for manual / mechanical control of encroaching woody species.

Conclusion: During the experimental program, the overall impact to vegetation in the GRSM is expected to be negligible and somewhat beneficial , therefore, nonsignificant.

4.1.2.2.4 Wildlife

Analysis: The GRSM is currently coordinating the All Taxa Biodiversity Inventory (ATBI) for the purpose of identifying all living organisms in the Park. The GRSM has a list of identified wildlife species; however, the ATBI is expected to list other wildlife species in one or more of the following categories. Numbers of identified species by category, include:

- 67 identified species of mammals
- 240 identified species of birds
- 36 identified species of reptiles
- 44 identified species of amphibians
- 58 identified species of freshwater fish
- 95 identified species of land snails, insects, and spiders (another 100 possible).

Elk are considered grazers feeding primarily on grasses supplemented with woody browse and acorns during the fall. Of the 540 species of animals, none are dependent upon grasses as a primary food source. Furthermore, sufficient browse is available for elk and white-tailed deer use. Unknown at this time is the significance elk will have on the annual acorn crop within the Park. A host of animals depend upon the acorn crop for food in the fall and winter. One of the main objectives of the experimental program is to determine the impact elk may have on the acorn food source within Park boundaries. If it is determined that elk have a significant negative impact upon other wildlife populations that utilize acorns as a primary food source, control measures may be implemented according to NPS policies.

Of the 540 species of animals, elk would be expected to compete with white-tailed deer for vegetative cover. However, this should not be a factor as demonstrated by other reintroduction efforts in eastern states.

Finally, elk coexist with the same or similar animal species throughout their western range and reintroduced locations in the east and should not significantly impact any of the wildlife species in the Park.

Since elk are expected to enhance vegetation diversity, they could as a consequence, also enhance wildlife diversity.

Conclusion: During the experimental program, impact to other wildlife in the GRSM has been determined to be negligible and therefore, nonsignificant.

4.1.2.2.5 Threatened and Endangered Species

Analysis: There are 19 animals (vertebrates and invertebrates) indigenous to the GRSM and surrounding area listed under the authority of the Endangered Species Act of 1973 as federally

endangered or threatened. In addition to these species, there are other animal species that are considered sensitive and in need of management. The GRSM has evaluated the habitat requirements and impact of competition for food and cover, as well as direct competition, predation, or habitat degradation, and determined that the elk should not impact any of these federally threatened and endangered animal species.

There are four plants indigenous to the GRSM listed under the authority of the Endangered Species Act of 1973 that are endangered or threatened. In addition to these species there are other plant species that are considered sensitive and in need of management. The possibility exists that any one or more of these species occur within an EUA or within areas elk will range. These species may be impacted by elk as a food source or trampled in trails, bedding areas, and/or wallows. If the Preferred Alternative is implemented, elk movement will be monitored continuously through the use of radio-telemetry. Whenever elk utilize sensitive areas, biologists will identify area use and determine if foraging and general use are impacting sensitive species thereby possibly implementing corrective measures to reduce to reduce adverse impacts.

Park personnel will consult with the US Fish and Wildlife Service to determine the specific action to be taken to ensure protection of federally listed and sensitive plant and animal species. Monitoring of sensitive plant and animal species will be evaluated by Park personnel during the experimental program.

Should the decision be made to implement the Preferred Alternative, informal consultation as required under Section 7 of the Endangered Species Act of 1973 will be conducted with the US Fish and Wildlife Service. If it is determined that the proposed action may result in adverse impacts to federally listed species, formal consultation will be conducted and concluded before elk are released in the Park.

In addition to federally listed plant and animal species, the Park maintains a list of 320 plant and animal species listed by the states of North Carolina and Tennessee. If adverse impacts are determined, measures to reduce or eliminate these impacts will be evaluated.

Conclusion: During the experimental program (2001 - 2005), the potential impact to threatened and endangered species is expected to be negligible and therefore, nonsignificant.

4.1.2.2.6 Cultural Resources

Analysis: Cultural resources in the Park include cabins, barns, churches, grain mills, wooden rail fences, cemeteries, as well as Native American burial areas, villages, and religious areas. Destruction of these structures and sites by elk ise not expected to occur. However, should elk acquire a preference for cultural resource areas, the GRSM will incorporate management actions to include such actions as enclosing the area with fencing; hazing the elk to encourage movement from the area; and/or removal of elk from the area. These actions should mitigate and prevent damage to cultural resources of the GRSM.

Conclusion: There should be no impact to cultural resources due to implementation of the Preferred Alternative; therefore the impact to cultural resources has been determined to be nonsignificant.

4.1.2.2.7 Air Quality

Analysis: The impact to air quality will be localized around bedding sites and wallows where strong odors of urine will emanate. These odors will remain in the bedding and wallow sites as long as elk use these locations. Due to the localized odor, the impact is not significant and will have no influence on the overall air quality of the Park.

Conclusion: The impact to air quality has been determined to be nonsignificant.

4.1.2.2.8 Sound Quality

Analysis: Elk will add new sounds to the GRSM ecosystem to include mews and bugling by bulls during the early fall mating season. These sounds will enhance the quality of the Park visitor's wilderness experience and are considered to be a very positive impact to park esthetics.

Conclusion: The impact to sound quality has been determined to be positive.

4.1.2.2.9 Visual Quality

Analysis: Park visitation is centered on the ecological enhancements within the Park boundary. Visitors expect to see outstanding vistas and wildlife within those vistas. Throughout the western range of the elk and within the areas of the Eastern United States where elk have been reestablished, people travel many miles to see elk in their natural habitat. Releasing elk in the GRSM will provide for a viewing experience and enhance the visual quality of the Park.

Conclusion: The impact to visual quality has been determined to be positive.

4.1.2.3 Adjacent Lands / People

Analysis: Due to ecological similarities of adjacent lands to the ecological characteristics of the GRSM, ecological impacts from elk should be similar to those discussed in previous sections of this document, assuming elk move outside of the Park boundary. If elk do not move outside of the Park boundary, no impact will occur from implementation of the Preferred Alternative.

If elk move outside the boundaries of the GRSM, the potential for property / real estate damage to adjacent landowners exists. Recognizing the potential for property / real estate damage, the GRSM has been cooperatively working with the following agencies to establish a plan for managing elk movement outside of Park boundaries during the experimental program; these are:

- TWRA
- NCWRC
- USDA Forest Service

- United State Fish and Wildlife Service
- Eastern Band of the Cherokee Indians
- Local agricultural groups

The plan is termed "Zone Management" (Figure 1) and is similar to an approach utilized by the State of Kentucky Department of Fish and Wildlife Resources to manage elk that stray outside the core area of Eastern Kentucky established for elk management. The Zone Management concept will be used throughout the experimental program (2001 - 2005).

The Zone Management approach delineates areas adjacent to the GRSM into two categories; these are:

- Buffer Zone
- No Elk Zone

Areas delineated within the Buffer Zone are directly adjacent to the Park boundary. Here, elk will be permitted unless significant conflicts or incidents are documented. If conflicts occur, elk will be removed. Areas outside the "Buffer Zone" will be designated as "No Elk Zones". Elk that enter these areas will be removed.

It should be noted that sensitive sites within the "Buffer Zone" will be noted as "No Elk Zones". Sensitive sites could include known sites of T&E species, farm crops, orchards, urban areas, golf courses, etc. Residents within the "Buffer Zone" can request that additional sensitive sites be considered for inclusion into the "No Elk Zone" if significant conflicts occur.

Mitigation of personal property and/or real estate outside of Park boundaries will be according to state of Tennessee and North Carolina rules and regulations addressing damage by wildlife.

Upon completion of the experimental program and if it can be determined that elk can sustain themselves in the forests of the Southeast, management of elk outside of the GRSM boundaries will be the sole responsibilities of the TWRA in Tennessee and NCWRC in North Carolina.

Conclusion: The management of elk utilizing a "Zone Management" approach has been determined to result in the best approach to managing potential conflicts with elk that leave the Park. The impacts to adjacent lands / people during the GRSM experimental program should be minor and therefore, nonsignificant.

4.1.2.4 Impacts to Elk

Impacts to elk used in the Preferred Alternative has been determined to be associated with the following items:

- Habitat suitability
- Exposure to new diseases
- Illegal hunting

- Translocation induced mortality
- Human disturbance
- Predators

Each of these impacts are presented in the following discussion.

4.1.2.4.1 Habitat Suitability

Analysis: A habitat suitability study of the GRSM was conducted by Long in 1996. He concluded that overall the habitat within the GRSM had 10 percent openings, which is the lower end of the scale use to evaluate habitat suitability with respect to elk. His conclusion was that the Park would support elk. The experimental program to be implemented by the Preferred Alternative has been designed to prove or disprove Long's conclusion.

Conclusion: Based upon Long's analysis, the impact to released elk, based upon habitat suitability, is expected to be a negligible impact and therefore, nonsignificant.

4.1.2.4.2 Exposure to New Diseases

Analysis: There are a few diseases present in the Southeast that may have an impact on the health of elk. These diseases are discussed below.

***Parelaphostrongylus tenuis*:** *P. tenuis*, a neurotrophic nematode parasite, known as the meningeal worm, is harbored asymptomatically by the white-tailed deer through the Southeast, except in the lower Coastal Plain. (Anderson 1972). Infection in elk can result in serious neurological damage caused when the nematodes migrate through the spinal cord and brain (Samuel et al. 1992). Not all elk succumb to infection. However, confirmed cases have occurred in elk reintroduced into Arkansas (Nettles and Corn 1998) and Kentucky (KDFWR 2000). The ultimate impact of the meningeal worm on elk reestablishment programs in the Southeast may depend upon the degree to which elk use the habitat occupied by the gastropod intermediate host of *P. tenuis.* The Kentucky Department of Wildlife has experienced a loss of less than one percent of reintroduced elk to *P. tenuis*. The loss was generally attributed to the yearling age class.

***Elaeophora schneideri*:** *E. schneideri*, an arterial worm parasitic nematode is pathogenic to elk. Infection of elk results in occlusion of arterial vessels and impaired blood supply to the neck and head. As a result, elk can develop blindness, neurologic deficits, and avascular necrosis of the ears and muzzle (Adcock and Hibler 1969). White-tailed deer in the Southeast can be infected with *E. schneideri*; however, infections are not common and appear to be prevalent in Arkansas and Louisiana as well as certain areas on the Atlantic and Gulf Coasts (Couvillion et al. 1985, Nettles and Corn 1998).

***Babesia odocoilei*:** *B. odocoilei* is a protozoan parasite of white-tailed deer that is probably endemic to the Southeast. Reports of occurrence are scattered through a wide area that includes Florida, New Mexico, Oklahoma, South Carolina, Texas, and Virginia. Furthermore, studies have revealed that the black legged tick, *Ixodes scapularis*, is the probable vector (Waldrup et al.

1990, 1992). This tick is widespread on white-tailed deer in the Southeast; thus, it is likely that elk will become exposed to *B. odocoilei*. It is not known if *B. odocoilei* could be a threat to elk because the taxonomic status of *B. odocoilei* is unclear in cervids (Nettles and Corn 1998).

Conclusion: Based upon ongoing studies in Kentucky and Arkansas, the potential of elk loss due to exposure to indigenous diseases has been determined to be acceptable. Furthermore, because elk once occupied the GRSM, they were exposed to these diseases prior to being extirpated by man. The impact to released elk, based upon exposure to new diseases, has been determined to be negligible and therefore, nonsignificant.

4.1.2.4.3 Illegal Hunting

Analysis: The GRSM has experienced illegal hunting since its founding. Although limited to the extent possible, the entire Park boundary is exposed to illegal hunting. One of the major areas of the Park is along the southwest section where illegal hunting of both large and small game mammals occurs. The species most hunted include the black bear, white-tailed deer, exotic European wild hog, and raccoon.

Recognizing that illegal hunting could be a negative impact, Park managers developed exclusionary and selection criteria during the program's decision-making process that prevented an EUA from being established near the Park boundary. However, it is still recognized that if elk move to the Park boundary, they have a moderate to high probability of being killed illegally. Due to the vast area within the Park boundaries, it is unlikely that illegal hunting will have a significant impact on the proposed action.

The GRSM will continue all enforcement action as a deterrent to illegal hunting.

Conclusion: The impact to released elk based upon illegal hunting has been determined to be negligible and therefore, nonsignificant.

4.1.2.4.4 Translocation Induced Mortality

Analysis: Translocation induced mortality has been a concern of transporting livestock and wild animals for many years. It has been the experience of wildlife managers to expect a mortality rate in elk to approximate up to 30 percent. The translocation event includes loading, transportation, unloading, holding, and the 30-day post release period.

Recent translocation of elk by the State of Kentucky and EINP over long distances has resulted in the development of procedures that have reduced translocation induced mortality to approximately five percent. The GRSM will use procedures developed by the State of Kentucky and Elk Island National Park when transporting elk from the source locations in Kentucky and Alberta, Canada.

Techniques to mitigate translocation induced mortality include:

- Pad critical areas of trailers

- Trailers that mask cold wind and have adequate drainage
- Sufficient water
- High nutrition food
- Sufficient straw for bedding
- Separation of species and age groups within trailers
- Removal of antlers
- Use most direct route from source to release
- Have acclimation pens ready and supplied with food and water

Conclusion: The impact to released elk based upon the experience of others regarding translocation induced mortality has been determined to be negligible and therefore, nonsignificant.

4.1.2.4.5 Human Disturbance

Analysis: Elk are highly mobile animals and have the ability to avoid human disturbance when they so choose. Within their western range, elk winter along the lower elevations and routinely come in contact with people on ranches, rural areas, subdivisions, and in towns. The only times human disturbance could impact free-ranging elk in the Park is during the breeding season in early fall and parturition and the first few weeks of calving during May and June. However, due to the vast area within the Park (510,000 acres outside of trail and road corridors) and the instinct of the cows to find a secluded area for parturition, it is not thought that human disturbance will impact the Preferred Alternative.

In order to reduce the potential of human disturbance during the experimental program, the GRSM will provide educational materials for Park visitors informing the dangers associate with harassment and close contact with elk. If necessary, educational signs will be posted in areas of elk use. Finally, status updates for the elk experimental program will be provided to visitors and Park personnel. Furthermore, elk exhibiting abnormal or aggressive behavior will be evaluated for possible implementation of appropriate management actions.

Conclusion: The impact to released elk from human disturbance has been determined to be negligible and therefore, nonsignificant.

4.1.2.4.6 Predators

Analysis: The GRSM has three predators that could impact the experimental release effort to some degree. These three predators are the black bear, coyote, and bobcat. However, elk survive throughout its current range in association with one or more of these predators without significant impacts. Furthermore, other reestablishment efforts in the eastern United States have proceeded where one or more of these predators coexist with elk. The experimental program to be implemented by the Preferred Alternative will investigate the impact that predators in the GRSM will have on released elk.

If deemed necessary and under published NPS policy, predators can be controlled for the purpose of wildlife impact management. Control of predators would be of last recourse and only implemented upon concurrence with all decision makers on the elk program.

Conclusion: It is believed that the black bear, coyote, and bobcat will not significantly impact the experimental release effort of elk in the GRSM. Based upon the experience of others, it appears the impact from predators should be negligible and therefore, nonsignificant.

4.2 Experimental Monitoring and Closeout Actions

An experimental monitoring program, titled *An Experimental Release of North American Elk to the Great Smoky Mountains National Park* has been proposed by Joseph D. Clark, Ph.D. Southern Appalachian Field Laboratory; Biological Resources Division, U.S. Geological Survey; University of Tennessee; Knoxville, Tennessee. The program will be supported and/or funded by the Rocky Mountain Elk Foundation; Friends of Great Smoky Mountains National Park; University of Tennessee, Knoxville; GRSM; and other organizations and agencies.

This 5-year (2001 - 2005) project involves a research associate under the supervision of Dr. Joseph D. Clark and a federal employee supervised by E. Kim DeLozier, Supervisory Wildlife Biologist of GRSM. A detailed study proposal will be prepared by the research associate and distributed to study cooperators. In addition, two undergraduate field assistants will assist the research associate each summer.

Initial transport from the source herd location and radio transmitter collaring at GRSM will take place during winter and spring of 2001 and continue through 2003. Data collection will occur from 2001 - 2004. Telemetry activities will occur 2005. The final report will be completed by the end of 2005.

4.2.1 Experimental Period Monitoring

Although a habitat assessment has been performed in the GRSM (Long 1996), the only way to objectively determine if repatriating elk to GRSM and the Southern Appalachian Mountains is feasible is through an experimental release program. If it is determined that elk repatriation is biologically feasible, Park managers can then determine whether such repatriation is desirable for the GRSM. At that time, protocols for elk population reestablishment and management at GRSM will be developed.

Objectives of this experiment are to:

- Determine dispersal and mortality rates of reintroduced elk
- Determine whether mortality or post-release movements vary by age, sex, or reproductive status
- Assess habitat use and compare with Long's (1996) findings
- Evaluate the effects of variable acorn production on elk demography

- Evaluate impacts of elk reintroduction (native vegetation, wildlife, agricultural crops, fence damage, highway mortality, safety)
- Assess the feasibility, methodology, approach, and probability of success of releasing elk to establish a permanent, viable population at GRSM.

Program actions include:

- Release of 25-30 elk per year in the GRSM for three (2001, 2002, 2003) years. Optimally, the age structure of released animals would approximate that of a natural herd (5 bulls, 2 yearling bulls, 2 bull calves, 8 cows, 4 yearling cows, and 4 calves).
- Elk will be captured in December or January and held for a period of up to 45 days prior to shipment
- Each elk will be given appropriate vaccinations and treated for parasites.
- Certificates of health will be issued by a licensed veterinarian prior to movement.
- Antlers from bulls will be removed to prevent injury to elk and humans.
- Elk will be transported to GRSM in January / February in cattle or horse trailers and placed in a holding facility to be constructed near the center of the EUA. Elk will be kept at this facility for a period of up to 90 days and then released (releases will be synchronized with spring green-up if possible). Supplemental food will be placed nearby, temporarily after release.
- GPS and/or VHF radio-transmitter collars will be placed on each elk.
- Radio-transmitter collars will also have on-board mortality sensors and VHF transmitters for conventional telemetry triangulation.
- A thorough habitat analysis will be performed. Habitat preferences will be estimated with compositional analysis (Aebischer et al. 1993) and satellite imagery.
- Elk scats will be collected for food habits analysis.
- Habitat models will be developed using GIS coupled with multivariate statistical techniques (Clark et al. 1993).
- GPS location data will be remotely downloaded using a command unit and fixed wing aircraft.
- Released calves will be equipped with expanding collars to accommodate growth.
- Providing elk calves can be reasonable captured, expandable collars will be incorporated on all newborns.
- Elk with GPS will be radio-located up to four times each day for a period of up to four years.
- Movement rates, home ranges, and dispersal will be calculated and compared according to age and sex, reproductive condition, etc.
- Mortality rates and causes will also be determined using a mortality indicator switch in the radio collars using techniques of Heisey and Fuller (1985).
- Dead elk will be removed for necropsy by biologists and veterinarians when feasible.
- Natality rates will be determined by observing radio collared cows during the calving period.

- Newborn calves will be captured, if possible, and fitted with expandable VHF radio collars and released for survival rate estimation.
- When feasible, elk will be darted and collars will be replaced before the batteries expire.
- Through radio telemetry, elk that are in close proximity to private landowners and sensitive areas can be identified. It can be quickly determined if damage has occurred or is likely to occur.
- Once the released elk establish home ranges, a series of exclosures will be constructed to monitor the effect elk may have on sensitive native vegetation.
- Park personnel and agencies will be notified when utilization of sensitive areas by elk is identified.

Use of dispersal, mortality, natality, and habitat use data, in conjunction with a population model, will determine the minimum number of elk required to establish a sustainable population at GRSM. Criteria for proximate success are:

- Most of the released elk successfully establish home ranges in the immediate vicinity of the region
- Projected reproduction exceeds mortality of released elk.

A number of alternatives will be presented, to include:

- Establishment of a resident herd wherever suitable habitat exists
- Establishment of a herd to serve as a core for expansion to public and private lands adjacent to the Park
- Removal of elk from the Park.

Procedures will be detailed to accomplish each objective. The goal is to provide information on a release strategy that has as low an impact as possible, while maximizing chances for ultimate success.

Annual reports will be prepared and submitted summarizing data collection and progress toward goals and completion of the project. Each report will be distributed to all cooperators so progress of the research can be assessed. A final report will be prepared containing all major data analyses and all key findings of the study and a report will be prepared for distribution to the general public. Papers with significant findings will be submitted to appropriate scientific journals. In addition, brochures, a newsletter, and a video will be prepared in cooperation with GRSM staff.

4.2.2 Closeout Actions

Closeout actions associated with the experimental program of the Preferred Alternative will result in one of the following actions:

- Leave elk in the GRSM
- Remove elk from the GRSM

4.2.2.1 Leave Elk in the GRSM

Based upon positive results of the experimental program, experimentally released elk and their descendents will be allowed to remain in the GRSM. A management plan will be developed for compliance with NPS-77 (USDI NPS 1978) that addresses the following items:

- Monitoring and regulation of the elk population
- Release of additional elk to sustain population
- Nuisance management
- Visitor safety
- Disease monitoring
- Vegetation monitoring
- Natality
- Mortality monitoring (causes / effects)
- Habitat management
- Visitor education
- Assisting state and federal resource managers outside of Park

The management plan will seek input from all GRSM natural resource managers. The management plan will be written within one year of experimental program closeout (2006).

4.2.2.2 Remove Elk from the GRSM

Based upon the conclusions of the five-year research program, it may be necessary to remove all elk from the GRSM. Should this action be necessary, elk will be trapped and transported to requesting agency lands or eliminated through direct reduction. It is estimated that this action could take up to three years to complete.

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6.0 LIST OF PREPARERS

Dwight C. Flynn
Senior Wildlife Biologist
Volunteer - Great Smoky Mountains National Park
MS Wildlife and Fisheries Science
BS Forest Management
Thirty years of experience in environmental management.

E. Kim DeLozier
Supervisory Wildlife Biologist
Great Smoky Mountains National Park
BS Wildlife and Fisheries Science
Twenty-five years of experience in wildlife and environmental management.

Joe Clark, Ph.D.
Southern Appalachian Field Laboratory
USGS / Biological Resources Division
The University of Tennessee
Knoxville, TN 37919
Twenty years of experience in wildlife research and management.

Shyamala Ratnayeke
Research Assistant
Department of Forestry, Wildlife, and Fisheries
The University of Tennessee
Knoxville, TN 37919
Four years of experience in wildlife research.

7.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM THIS ENVIRONMENTAL ASSESSMENT WAS SENT FOR REVIEW AND EXPERTS / INDIVIDUALS CONSULTED DURING PREPARATION

Agencies, Organizations, and Persons to whom this Environmental Assessment Was Sent for Review

- Mr. Keith Langdon, Inventory & Monitoring Coordinator
- Dr. Larry Hartmann, Chief, Resource Management and Science
- Mr. Bob Miller, Management Assistant
- Mr. Carroll Schell, Chief, Natural Resources Branch
- Ms. Janet Rock, Botanist
- Ms. Rebecca Nichols, Entomologist

Great Smoky Mountains National Park
107 Park Headquarters Road
Gatlinburg, Tennessee 37738

- Mr. Mark A. Cantrell, Fish and Wildlife Biologist
- Ms. Nora Murdock, Fish and Wildlife Biologist

U.S. Fish & Wildlife Service
Asheville Field Office
160 Zillicoa Street
Asheville, North Carolina 28801

- Mr. Stuart Johnson, Chief, Division of Planning / Southeast Region
- Mr. John Fischer, Park Planner / Southeast Region
- Mr. Steve Price, Environmental Protection Specialist

National Park Service
Southeast Region
Sam Nunn Atlanta Federal Center, 1924 Building
100 Alabama Street, S.W.
Atlanta, Georgia 30303

-
-

Experts / Individuals Consulted During Preparation of the Environmental Assessment

- Dr. Victor Nettles, Director

Southeastern Cooperative Wildlife Disease Study
The University of Georgia
Athens, Georgia 30602-7393

- Dr. Bruce Chisholm, D.V.M., Primary Products Inspector
- Dr. R.H. Burt, D.V.M., District Veterinarian

Canadian Food Inspection Agency
J.G. O'Donaghue Bldg.
Edmonton, Alberta, Canada T6H5T6

- Carl W. Betsill, Wildlife Biologist/Section Manager
- David T. Cobb, Ph.D., Chief/Division of Wildlife Management
- Mr. Scott Osborne, Big Game Coordinator

North Carolina Wildlife Resources Agency
512 N. Salisbury Street
Raleigh, North Carolina 27604-1188

- Dr. Gary Swinger

Tennessee Department of Health & Environment
Communicable Disease Control
Cordell Hull Bldg., 4th Floor
426 5th Ave. North
Nashville, Tennessee 37247-4911

- Dr. M.A. Mixson, State Veterinarian
- Dr. Thomas J. McGinn, III, Assistant State Veterinarian
- Dr. C.F. Kirkland, Director of Field Forces
- Dr. David J. Waldrep, Veterinary Diagnostician
- Dr. George Edwards, State Veterinarian (Retired)
- Dr. John K. Atwell, State Veterinarian (Retired)

North Carolina Department of Agriculture
P.O. Box 26026
Raleigh, North Carolina 27611

- Leon D. Jones, Principal Chief
- David Ensley, Cherokee Fish & Game Management

Eastern Band of Cherokee Indians
P.O. Box 455
Cherokee, North Carolina 28719

- Dr. David S. Maehr, Assistant Professor/Conservation Biology

University of Kentucky
203 Thomas Poe Cooper Bldg.
Lexington, Kentucky 40546-0073

- Lou Cornicelli, Wildlife Manager

State of Utah/Dept. of Natural Resources
Division of Wildlife Resources
515 East 5300 South
Ogden, Utah 84405-4599

- Dr. Ronald Wilson, State Veterinarian
- Dr. Robert Hartin, State Veterinarian (Retired)

Tennessee Department of Agriculture
Regulatory Services
Box 40627, Melrose Station
Nashville, Tennessee 37204

- Mr. Bill Pendergrass, Executive Director

Tennessee Cattleman's Association
610 West College Street
Suite 204
Murfreesboro, Tennessee 37130

- Mr. Chester Lauder, Beef, Dairy, Natural Resources Leader

North Carolina Farm Bureau Federation
P.O. Box 27766
Raleigh, North Carolina 27611

- Mr. Ken Purser, District Field Service Director

Tennessee Farm Bureau Federation
P.O. Box 496, 144 Main Street
Dayton, Tennessee 37321

- Dr. Michael Miller, Wildlife Veterinarian

Colorado Division of Wildlife
Wildlife Research Center
317 West Prospect Road
Fort Collins, Colorado 80526-2097

- Dr. Elizabeth S. Williams

University of Wyoming
Department of Veterinarian Sciences
1174 Snowy Range Road
Laramie, Wyoming 82070

- Dr. Trent Bollinger

Cooperative Wildlife Health Care
University of Sasketchewan
Saskatoon, Saskatchewan Canada SK S7N 5B4

- Dr. Margo Pybus, Wildlife Disease Specialist

Alberta Fish and Wildlife
6909-116 Street
Edmonton, Alberta Canada T6H 4P2

- Dr. Jim Logan, Interim State Veterinarian

State Of Wyoming/Wyoming Livestock Board
2020 Carey Avenue, 4th Floor
Cheyenne, Wyoming 82002-0051

- Dr. Walter Cook

Wyoming State Veterinary Laboratory
1174 Snowy Range Road
Laramie, Wyoming 82070

- Dr. Terry Kreeger, Supervisory, Veterinary Research Services

State of Wyoming/Wyoming Game and Fish Department
2362 Highway 34
Wheatland, Wyoming 82201-0108

- Dr. Doug Houston, Research Scientist/Olympic National Park

3822 Mt. Angles Rd.
Port Angeles, Washington 98362

- Dr. Peter M. Schantz, V.M.D.

National Center for Infectious Diseases
Centers of Disease Control and Prevention
Mailstop F22
4770 Burford Highway
Atlanta, Georgia 30341

- Dr. Joseph D. Clark, Laboratory Director

USGS, Biological Resources Division
Southern Appalachian Field Laboratory
University of Tennessee, Dept. of Forestry, Wildlife & Fisheries
Knoxville, Tennessee 37901-1071

-

- Mr. Rawley Cogan, Wildlife Biologist-Elk Management

Pennsylvania Game Commission, Bureau of Wildlife Management
R.D.#2, Box 305
Weedville, Pennsylvania 15868

- Dr. Richard C. Rosatte, Senior Research Scientist

Ontario Ministry of Natural Resources
Trent University, P.O. Box 4840
Peterborough, Ontario, Canada K9J 8N8

- Dr. Josef Hamr, Director/Northern Envir. Heritage Institute

Cambrian College of Applied Arts and Technology
1400 Barrydowne Road
Sudbury, Ontario, Canada P3A 3V8

- Mr. Rob Kaye, Senior Park Warden
- Mr. Norm Cool, Wildlife Biologist

Elk Island National Park
R.R. #1, Site 4
Fort Saskatchewan, Alberta, Canada T8L 2N7

- Dr. Ray Anderson, Elk Research Team Leader

University of Wisconsin-Stevens Point
P.O. Box 429
Clam Lake, Wisconsin 54517

- Mr. Bundy Plyer, President

North Carolina Cattleman's Association
Raleigh, North Carolina 27611

- Mr. Larry Marcum, Chief of Wildlife
- Mr. Doug Scott, Wildlife Biologist
- Mr. Willard Perryman, Blount County Wildlife Officer
- Ms. Shelley Johnson, Cocke County Wildlife Officer
- Mr. David Sexton, Sevier County Wildlife Officer

Tennessee Wildlife Resources Agency
P.O. Box 40747
Nashville, Tennessee 37204

- Mr. Roy Grimes, Chief of Wildlife
- Mr. John Phillips, Deer Project Coordinator
- Mr. Charlie Logsdon, Elk Project Coordinator

Kentucky Department of Fish and Wildlife Resources
#1 Game Farm Road
Frankfort, Kentucky 40601

- Dr. John C. New, Professor

College of Veterinary Medicine/The University of Tennessee
Department of Comparative Medicine
P.O. Box 1071
Knoxville, Tennessee 37901-1071

- Mr. Keith Langdon, Inventory & Monitoring Coordinator
- Mr. Leon Konz, Fire Management Coordinator
- Dr. Larry Hartmann, Chief, Resource Management and Science
- Mr. Phil Francis, Acting Superintendent
- Mr. Bob Miller, Management Assistant
- Mr. Carroll Schell, Chief, Natural Resources Branch
- Ms. Janet Rock, Botanist

Great Smoky Mountains National Park
107 Park Headquarters Road
Gatlinburg, Tennessee 37738

- Mr. John Ramey, Forest Supervisor
- Mr. Rod McClanahan, Wildlife Biologist

USDA/Forest Service/National Forest in North Carolina
160 Zillicoa, P.O. Box 2750
Asheville, North Carolina 28802

- Ms. Anne Zimmerman, Forest Supervisor
- Ms. Laura Mitchell, Wildlife Biologist

USDA/Forest Service/National Forest in Tennessee
P.O. Box 2010
Cleveland, Tennessee 37320

- Ms. Ann W. Wright, General Manager
- Mr. Steve Bloemer, Wildlife Biologist

USDA/Forest Service/Land Between the Lakes
100 Van Morgan Drive
Golden Pond, Kentucky 42211

Appendix I

National Park Service 2000 Strategic Plan (Draft) Goals

National Park Service 2000 Strategic Plan (Draft) Goals

- **Category I Goals - <u>Preserve Park Resources</u>** - reflect the NPS 1916 Organic Act *to conserve the scenery and the natural and historic objects and the wildlife therein.*

Mission Goal Ia: Natural and cultural resources and associated values are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.

Mission Goal Ib: The NPS contributes to knowledge about natural and cultural resources and associated values; management decisions about resources and visitors are based on adequate scholarly and scientific information.

- **Category II Goals - <u>Provide for the Public Enjoyment and Visitor Experience of Parks</u>** - reflect the NPS Organic Act mandate *to provide for the enjoyment of the resources in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.*

Mission Goal IIa: Visitors safely enjoy and are satisfied with the availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities.

Mission Goal IIb: Park visitors and the general public understand and appreciate the preservation of parks and their resources for this and future generations.

- **Category III Goals - <u>Strengthen and Preserve Natural and Cultural Resources and Enhance Recreational Opportunities Managed by Partners</u>** - reflect the NPS legislated partnership programs to protect resources not directly managed by the NPS.

Mission Goal IIIa: Natural and cultural resources are conserved through formal partnership programs.

Mission Goal IIIb: Through partnerships with other federal, state, and local agencies and non-profit organizations, a nationwide system of parks, open space, rivers, and trails provide educational, recreational, and conservation benefits for the American people.

Mission Goal IIIc: Assisted through federal funds and programs, the protection of recreational opportunities is achieved through formal mechanisms to ensure continued access for public recreational use.

- **Category IV goals - <u>Ensure Organizational Effectiveness</u>** - support the mission of the NPS to have efficient and effective processes.

Mission Goal IVa: The NPS uses current management practices, systems, and technologies to accomplish its mission.

Mission Goal IVb: The NPS increases it managerial capabilities through initiatives and support from other agencies, organizations, and individuals.

Appendix II

National Park Service Natural Resources Management Guideline NPS 77

Natural Resources Management Guideline - NPS 77

NPS-77 states that restoration of native species may only occur once specific determinations or preparations have been made addressing the proposed action. These specific determinations or preparations are:

- *Adequate proof exists that the species occurred in the area and that its absence is human caused. A habitat analysis should be conducted to verify that enough land and water area exists to support a viable population of the species. All other essential elements, including water, forage, nest or den sites, cover, and others should exist.*

- *A restoration action plan has been developed.*

- *There is an adequate source of animals.*

- *There are no significant problems with predators at the release site or the problems with predators can be resolved.*

- *A review concludes that the extirpation was human caused.*

- *A review indicates that the prospects for natural reestablishment are minimal but that restoration has a good chance for success.*

Included in the overall evaluation is the development of a restoration action plan that addresses the proposed action. The restoration plan must include:

- *An analysis of the selection of source animals to include the most closely related individuals with regard to size, external morphology, genetic background, and behavior to the extirpated species, except where other considerations exist.*

- *Preparation for the safest and most humane transport of the source stock.*

- *An analysis of the best release sites that minimize conflicts with native predators and humans to afford the released animals the best chance of survival and procreation.*

- *Possible temporary holding of the source stock in a structure or enclosure until they have acclimated or where a soft release (acclimation period prior to release) is desired. Any disadvantages to the use of the facility, such as increased transmission of disease or increased vulnerability to predators, should be recognized and weighed against the benefits of utilizing the enclosure. The enclosure or structure should be removed after release, except where it benefits the recovering species, in which case it should be removed after the recovery is complete.*

Appendix III

United States Federal and State Compliance / Canada and Canadian Province Compliance Requirements for Elk Movement

United States Federal and State Compliance / Canadian and Canadian Province Compliance Requirements for Elk Movement

United States Federal and State Compliance

- Act of May 22, 1926 (Act established GRSM)
- National Parks Omnibus Management Act of 1998
- National Park Service Organic Act of 1916
- National Park System General Authorities Act
- National Park System Resource Protection Act
- Wilderness Act
- Endangered Species Act of 1973
- Federal Insecticide, Fungicide and Rodenticide Act
- Clean Air Act
- Animal Welfare Act
- National Historical Preservation Act of 1966
- US Department of Transportation Rules and Regulations
- US Department of Agriculture; Animal and Plant Inspection Health Service (APHIS) CFR Title 9; Parts 93.404 through 93.421
- Executive Order No.12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- Executive Order No. 11644 – Use of Off-road Vehicles on Public Lands
- National Park Service, Draft Strategic Plan (2000); January 2000
- National Park Service Management Plan – 1988
- National Park Service Draft Management Policies - 2000
- NPS Director's Order # 2: Park Planning
- NPS Director's Order # 7: Volunteers in Parks
- NPS Director's Order # 10: Design and Construction Drawings
- NPS Director's Order # 12: Conservation Planning and Environmental Impact Analysis
- NPS Director's Order # 25: Land Protection
- NPS Director's Order # 41: Wilderness Protection & Management
- NPS Director's Order # 60A: Aviation Management
- NPS Director's Order # 60B: Aerial Capture and Tagging of Animals
- NPS Director's Order # 73: Resource Management Plans
- NPS Director's Order # 74: Studies and Collecting
- NPS Director's Order # 75: Media Relations
- NPS-77 (Natural Resources Management Guideline - Natural Resource Management)
- Great Smoky Mountains National Park Management Plan of 1983
- Rules of State of Tennessee Wildlife Resources Agency Chapter 1660-1-15 - Animal Importation
- Rules of the State of Tennessee Department of Agriculture Chapter 0080-1 – Health Requirements for Admission and Transportation of Livestock and Poultry

- Rules of the State of Tennessee Department of Agriculture Chapter 0080-2-5 – Brucellosis Testing and Quarantine Regulations
- State of Tennessee Department of Transportation Rules and Regulations
- Rules of State of North Carolina Department of Agriculture and Consumer Service
- Rules of State of North Carolina Department of Environment and Natural Resources
- State of North Carolina Department of Transportation
- State of Montana Department of Transportation Rules and Regulations
- State of Montana Department of Agriculture Rules and Regulations
- State of Montana Department of Fish, Wildlife, and Parks Rules and Regulations
- State of Wyoming Department of Transportation Rules and Regulations
- State of Wyoming Department of Agriculture Rules and Regulations
- State of Wyoming Department of Game and Fish Rules and Regulations
- State of South Dakota Department of Transportation Rules and Regulations
- State of South Dakota Department of Agriculture Rules and Regulations
- State of South Dakota Department of Game, Fish and Parks Rules and Regulations
- State of Minnesota Department of Transportation Rules and Regulations
- State of Minnesota Department of Agriculture Rules and Regulations
- State of Minnesota Department of Natural Resources Rules and Regulations
- State of Iowa Department of Transportation Rules and Regulations
- State of Iowa Department of Agriculture Rules and Regulations
- State of Iowa Department of Natural Resources Rules and Regulations
- State of Illinois Department of Transportation Rules and Regulations
- State of Illinois Department of Agriculture Rules and Regulations
- State of Illinois Department of Natural Resources Rules and Regulations
- State of Indiana Department of Transportation Rules and Regulations
- State of Indiana Department of Agriculture Rules and Regulations
- State of Indiana Department of Natural Resources Rules and Regulations
- State of Kentucky Department of Transportation Rules and Regulations
- State of Kentucky Department of Agriculture Rules and Regulations
- State of Kentucky Department of Fish and Wildlife Resources Rules and Regulations

Canadian and Canadian Province Compliance

- Alberta Environmental Protection Agency Rules and Regulations
- Canadian Wildlife Service Rules and Regulations
- Parks Canada Rules and Regulations
- Canadian Food Inspection Agency Rules and Regulations

Appendix IV

Exclusionary Criteria

Exclusionary Criteria

As the means of evaluation and the first step in the decision-making process, GRSM and University of Tennessee biologists developed a set of exclusionary criteria that define a fact or situation that would prevent an action from happening.

The following discussion presents development of all exclusionary criteria used for the evaluation of source herds and release sites. These criteria have been numbered for ease of discussion and presentation. No criterion has precedent over another. Any one of the criteria, standing alone, will prevent a proposed action in its entirety.

Categorical Exclusionary Criteria

1 - Experimental release request denial by the US Department of Interior, NPS
2 - Noncompliance with USDA Animal and Plant Health Inspection Service (APHSI) rules and regulations
3 - Lack of adequate proof documenting that elk occurred in the area and that its absence was human caused
4 - Absence of an adequate source of animals
5 - Significant problems with predators identified to exist at the release site
6 - Extirpation of elk was not human caused
7 - Prospects for natural reestablishment of elk is high
8 - Experimental release of elk has a less than average chance for success

Location of Source Herd Exclusionary Criteria

1 - Absence of historical disease monitoring for source herd
2 - Documented evidence of Chronic Wasting Disease (CWD) in source herd
3 - Documented evidence of current bovine tuberculosis (TB) in source herd
4 - Documented evidence of current brucellosis in source herd
5 - Documented evidence of current *E. cervi* in source herd
6 - Documented evidence of current septicemic pasteurellosis in source herd
7 - Ranched / farmed source herd

Release Site / Effective Use Area Exclusionary Criteria

1 - Access by motorized ground vehicle is not available or allowed
2 - Release site / EUA is within 5 miles of an urban area
3 - High historical incidents of poaching within GRSM boundaries

Table A-4 (Exclusionary Criteria Analysis) presents a list of potential elk sources and release sites / EUAs that were evaluated for exclusionary criteria. The number(s) in Table A-4 represent the criteria used for excluding further evaluation of the action.

Table A-4 Exclusionary Criteria Analysis

Action	Criteria
Categorical Exclusions	None
Location / Health of Source Heard	
Elk Island National Park - Alberta, Canada	None
US Forest Service, Land Between The Lakes - Tennessee & Kentucky	None
State of Idaho	1*
State of Kansas	1
Theodore Roosevelt National Park	1
Wind Cave National Park	1
State of Michigan	1
State of Pennsylvania	1
State of Arkansas	1
Release Sites / Effective Use Areas	
Bone Valley / Hazel Creek - North Carolina	None
Cades Cove - Tennessee	None
Cataloochee - North Carolina	None
Parsons Branch Road - Tennessee	None
Mt. Collins - Tennessee & North Carolina	None
Tunnel / Lake View - North Carolina	5
Bradley Fork / Smokemont - North Carolina	4, 5
Spence Field / Russell Field - Tennessee & North Carolina	1

* The number(s) represent the exclusionary criteria used for excluding further evaluation of the action.

The exclusionary criteria analysis eliminated seven of the nine potential source herd locations. The two potential source herd locations remaining after applying exclusionary criteria are:

- Elk Island National Park - Alberta, Canada
- USFS Land Between The Lakes - Western Kentucky.

The exclusionary criteria analysis eliminated three of the eight potential release sites / EUAs. The five feasible release areas / EUAs remaining after applying exclusionary criteria are:

- Bone Valley / Hazel Creek - North Carolina
- Cades Cove - Tennessee (area removed from consideration)
- Cataloochee - North Carolina
- Parsons Branch Road - Tennessee
- Mt. Collins - Tennessee & North Carolina.

Appendix V

Weighted Selection Criteria

Weighted Selection Criteria

Further evaluation required the development of weighted selection criteria to be used in ranking proposed actions.

The following discussion presents development and application of weighted selection criteria developed for both the source herd locations and release sites / EUAs. These criteria were numbered for ease of discussion and presentation. Numbered weights were assigned for an action, fact, or to represent a numeric range. The weighted numbers were summed and presented as to the highest ranking to the lowest ranking. Please be advised that the highest-ranking action may not be the one selected for the experimental release program due to other actions that will be evaluated during the NEPA process.

Location of Source Herd

- **Location**

  3 - East of Rocky Mountain Continental Divide (US and Canada)
  2 - Western Slopes of Rocky Mountains (US and Canada)
  1 - Pacific Coast States and Canadian Provinces

- **Genetic Similarity To Eastern Elk**

  3 - Manitoban Elk
  2 - Rocky Mountain Elk
  1 - Roosevelt Elk
  1 - Tule Elk

- **Distance From Source Herd To GRSM**

  5 - < 250 miles
  4 - 251 - 500 miles
  3 - 501 - 750 miles
  2 - 751 - 1,000 miles
  1 - > 1,000 miles

Health Of Source Herd

- **Disease Monitoring**

3 - Five year disease monitoring program - CWD, TB, Brucellosis
2 - Three year disease monitoring program - CWD, TB, Brucellosis
1 - Less than three year disease monitoring program - CWD, TB, Brucellosis

- **Parasites**

2 - *Echinococcus granulosis*, *Dermacentor andersoni*, *Ixodes pacificus*, and/or Mites (*Psoroptes)* not identified in source herd
1 - *Echinococcus granulosis, Dermacentor andersoni, Ixodes pacificus,* and/or Mites (*Psoroptes)* identified in source herd

Analysis Of Release Sites / Effective Use Areas

EUAs were defined as 20,000 acres centered around the soft release site that will include the holding pen. The release sites / EUAs that remained after exclusionary criteria included two locations in Tennessee, two locations in North Carolina, and one location in both Tennessee and North Carolina. The release sites / EUAs are:

- Cades Cove - Tennessee (area removed from consideration)
- Parsons Branch Road - Tennessee
- Bone Valley / Hazel Creek - North Carolina
- Cataloochee - North Carolina
- Mt. Collins - Tennessee & North Carolina

Release Site / Effective Use Areas

- Habitat Suitability Indices (HSI) (Developed from a habitat analysis developed by Long [1996]. The authors applied each of the indices that Long had identified for forest and open areas thus enabling the analyst to evaluate the diverse habitat of each location [Appendix I]).

  10 - SI value range from .90 to 1.0
  9 - SI value range from .80 to .89
  8 - SI value range from .70 to .79
  7 - SI value range from .60 to .69
  6 - SI value range from .50 to .59
  5 - SI value range from .40 to .49
  4 - SI value range from .30 to .39
  3 - SI value range from .20 to .29
  2 - SI value range from .10 to .19
  1 - SI value range from .00 to .09

- Ground transportation / access to and within release area

  4 - Paved / unpaved roads without trespass restriction
  3 - Trails and roads approved for pack animal traffic
  2 - Network of foot traffic trails
  1 - No roads or trails

- Removal of dead elk for necropsy from within release area

  3 - Accessible by ground vehicle without restrictions
  2 - 50 percent or less of study area accessible by ground vehicle without restriction / 50 percent or more accessible by helicopter
  1 - Accessible only by helicopter

- Communication within effective use area to GRSM headquarters

  4 - Entire study area covered by two-way communications
  3 - 50 percent or more of study area covered by two-way communications
  2 - Less than 50 percent of study area covered by two-way communications
  1 - None of the study area covered by two-way communications

- Distance from GRSM Headquarters

  3 - < 25 miles
  2 - 26 - 50 miles
  1 - > 51 miles

- Accessibility logistics for ground transportation

  3 - No access logistics problems
  2 - Seasonal logistics problems
  1 - Year round logistics problems

- Spring food availability for majority of effective use area

  3 - March through April
  2 - April through May
  1 - May through June

- Topographical characteristics of acclamation pen site

  3 - 10 percent slope or less
  2 - 11 percent - 20 percent slope
  1 - Greater than 20 percent slope

- Telemetry data acquisition

  3 - All effective use area open for ground surveillance
  2 - 50percent ground surveillance / 50 percent air surveillance
  1 - 100percent air surveillance

- Field camp quality

    3 - Permanent structure with one or more utilities
    2 - Permanent structure without utilities
    1 - Temporary structures

- Habitat Management

    3 - EUA scheduled for prescribed burn within 1 - 2 years of January 1, 2000
    2 - EUA scheduled for prescribed burn within 3 - 4 years of January 1, 2000
    1 - EUA not scheduled for prescribed burn within 5 years of January 1, 2000

Analysis Ranking Of Potential Source Herds And Release / Effective Use Areas

Location of Source Herds

- Elk Island National Park - Alberta, Canada

Ranking Criteria	***Ranking***
Location	3
Distance From Source Herd To GRSM	1
Genetic Similarity To Eastern Elk	3
Disease Monitoring	3
Parasites	1
	11

- US Forest Service, Land Between The Lakes - Tennessee & Kentucky

Ranking Criteria	***Ranking***
Location	3
Distance From Source Herd To GRSM	4
Genetic Similarity To Eastern Elk	3
Disease Monitoring	3
Parasites	1
	14

Release Site / Effective Use Areas

- Cades Cove - Tennessee

Ranking Criteria	***Ranking***
HSI For Effective Use Area	10
Ground Transportation / Access To And Within Effective Use Area	4
Removal Of Dead Elk For Necropsy From Within Effective Use Area	2
Communication Within Effective Use Area With GRSM Headquarters	4
Distance From GRSM Headquarters	2
Accessibility Logistics For Ground Transportation	3
Spring Food Availability For Majority Of Effective Use Area	3
Topographic Characteristics Of Acclamation Site	3
Telemetry Data Acquisition	2
Field Camp Quality	3
Habitat Management	3
	39

- Parsons Branch Road - Tennessee

Ranking Criteria	***Ranking***
HSI For Effective Use Area	9
Ground Transportation / Access To And Within Effective Use Area	4
Removal Of Dead Elk For Necropsy From Within Effective Use Area	2
Communication Within Effective Use Area With GRSM Headquarters	4
Distance From GRSM Headquarters	2
Accessibility Logistics For Ground Transportation	3
Spring Food Availability For Majority Of Effective Use Area	3
Topographic Characteristics Of Acclamation Site	2
Telemetry Data Acquisition	2
Field Camp Quality	3
Habitat Management	3
	37

- Bone Valley / Hazel Creek - North Carolina

Ranking Criteria	***Ranking***
HSI For Effective Use Area	9
Ground Transportation / Access To And Within Effective Use Area	4
Removal Of Dead Elk For Necropsy From Within Effective Use Area	2
Communication Within Effective Use Area With GRSM Headquarters	4
Distance From GRSM Headquarters	1
Accessibility Logistics For Ground Transportation	2
Spring Food Availability For Majority Of Effective Use Area	3
Topographic Characteristics Of Acclamation Site	3
Telemetry Data Acquisition	2
Field Camp Quality	3
Habitat Management	1
	34

- Cataloochee - North Carolina

Ranking Criteria	***Ranking***
HSI For Effective Use Area	9
Ground Transportation / Access To And Within Effective Use Area	4
Removal Of Dead Elk For Necropsy From Within Effective Use Area	2
Communication Within Effective Use Area With GRSM Headquarters	4
Distance From GRSM Headquarters	1
Accessibility Logistics For Ground Transportation	3
Spring Food Availability For Majority Of Effective Use Area	3
Topographic Characteristics Of Acclamation Site	3
Telemetry Data Acquisition	2
Field Camp Quality	2
Habitat Management	2
	35

- Mt. Collins - Tennessee & North Carolina

Ranking Criteria	***Ranking***
HSI For Effective Use Area	9
Ground Transportation / Access To And Within Effective Use Area	4
Removal Of Dead Elk For Necropsy From Within Effective Use Area	2
Communication Within Effective Use Area With GRSM Headquarters	4
Distance From GRSM Headquarters	3
Accessibility Logistics For Ground Transportation	2
Spring Food Availability For Majority Of Effective Use Area	1
Topographic Characteristics Of Acclamation Site	1
Telemetry Data Acquisition	2
Field Camp Quality	1
Habitat Management	1
	30

Table A-5 (Analysis / Ranking Of Potential Source Herd Locations and Release / Effective Use Areas) presents the results of the ranking process for the Phase I release program.

Table A-5 Analysis / Ranking of Potential Source Herd Locations and Release / Effective Use Areas

Location of Source Herds	**Numeric Ranking**
USFS Land Between The Lakes	14*
Elk Island National Park	11
Release Sites / Effective Use Areas	
Cades Cove - Tennessee	39*
Parson Branch Road - Tennessee	37
Bone Valley / Hazel Creek - North Carolina	34
Cataloochee - North Carolina	35
Mt. Collins - Tennessee & North Carolina	30

* Highest number represents the preferred action.

Due to current management issues (transportation, visitation, etc.) and other planning processes, Cades Cove will not be used as a EUA during the experimental program.

Appendix VI

Significant Diseases and Parasites of Elk

Significant Diseases of Elk

The Southeastern Cooperative Wildlife Disease Study (SCWDS) composed a literature review of known diseases and parasites not only in the United States but worldwide that have been documented to afflict all subspecies of red deer (elk) both indigenous, introduced, and farmed populations.

Significant diseases that were identified by the SCWDS:

- Chronic Wasting Disease (CWD)
- Bovine Brucellosis
- Bovine Tuberculosis (TB)
- Paratuberculosis
- *Elaphostrongylus cervi*
- Septicemic pasteurellosis

Parasites that are harbored by elk and worthy of mentioning include:

- *Echinococcus granulosis* (a species of tapeworm)
- Giant liver fluke (*Fascioloides magna*)
- Non-endemic species of ticks (*Dermacentor andersonii* and *Ixodes pacificus*)
- Mites (*Psoroptes*).

Chronic Wasting Disease (CWD): CWD is a specific transmissible spongiform encephalopathy (TSE) affecting free-ranging and captive mule deer, white-tailed deer, and elk. This disease was first observed by biologists with the Colorado Division of Wildlife in a captive mule deer in the late 1960s. The disease was diagnosed as a spongiform encephalopathy in captive deer and elk in 1978. In 1981, a free-ranging elk from the Rocky Mountain National Park was found with CWD. The first free-ranging mule deer with CWD was found northwest of Fort Collins, Colorado in 1984 (Spraker 1998).

CWD has only been found in free-ranging deer and elk in northeastern Colorado and southeastern Wyoming. The prevalence of CWD in deer is highest (approximately 5 percent in a relative small area bounded by the Wyoming border; Fort Collins, Colorado; Rocky Mountain National Park, Colorado; and Estes Park, Colorado. The prevalence of CWD in elk in the same area is less than 1 percent (Spraker 1998). There have been no free-ranging animals found to be positive that did not originate from the endemic areas. (USDA APHIS 1999).

CWD has been found in captive cervids including mule deer, white-tailed deer, black-tailed deer and elk (Spraker et al. 1997). Reports of CWD in captive herds include:

- Elk - Western South Dakota (SCWDS Briefs 1998)
- Elk - Nebraska (SCWDS Briefs 1998)

- Elk - Oklahoma (Nettles and Corn 1998)
- Elk - Montana (RMEF Bugle, 2000)
- Mule Deer - Ontario, Canada zoo (imported from the CWD-endemic area in Colorado (Williams and Young 1992)
- Elk - Saskatchewan, Canada (imported from a ranch in South Dakota) (Nettles and Corn 1998).

CWD raises special concern because information regarding its origin, causative agents, and mode of transmission is not fully understood. Moreover, the incubation period can range from 24 to 36 months (Miller personal communication 2000) and diagnostic tests for live animals do not exist (Nettles and Corn 1998). Symptoms of CWD include emaciation, behavioral changes, physical weakness, brain lesions in the form of microcavitation in the gray matter, and neuronal degeneration. The disease is associated with accumulations of certain proteins called prions that are thought to convert normal brain proteins to abnormal proteins (Spraker et al. 1997).

Definitive signs of CWD require necropsy of dead animals (Nettles and Corn 1998, Williams and Young 1992). Tests include histopathology of specific brain nuclei, immunohistochemistry for altered prion protein, western blot analysis, and electron microscopy (Spraker et al. 1997). Signs of CWD can readily be detected in brains examined microscopically soon after death. In less fresh carcasses, microscopy may be supplemented by immunostaining for abnormal prion proteins or demonstrating the presence of scrapie-associated fibrils (Williams and Young 1992).

Evidence indicates that the disease is naturally transmissible only among cervids. However, a variety of ruminant species, including domestic cattle, have been resident in facilities with CWD-infected deer or elk and only cervids developed the disease (Williams and Young 1992). CWD has been known to occur around the Fort Collins, Colorado, area for over 30 years and during this time there have been no cases of a spongiform encephalopathy in cattle there or anywhere else in the United States. To date there is no indication that CWD is naturally transmissible to other native or domestic non-cervid ruminant species or humans (Spraker 1998). There is no known relationship between CWD and any other spongiform encephalopathy of animals or people (USDA APHIS 1999).

Bovine Brucellosis*:* Bovine Brucellosis is a bacterial disease caused by the bacterial genus *Brucella abortus*. The disease causes inflammation of the endometrium and placenta, usually leading to abortion or premature birth in cattle and wild ruminants. Brucella infection in livestock populations can cause severe economic loss.

Brucella abortus, which is pathogenic to a wide range of animal hosts, including man, is usually contracted through ingesting infected raw milk (Hendricks and Meyer 1975), but other modes of transmissions such as direct skin contact with fetal membranes and newborn animals is reported (Borts 1945). Herding animals contract the disease through exposure to infected fetuses and placental tissue, which might contaminate pasture, feeding supplies, and water. Also, carnivores that consume infected fetuses can transport the disease to other areas. Brucellosis is common in wild elk inhabiting the Greater Yellowstone Area in Wyoming, Idaho, and Montana (Thorne et al. 1978) but is not prevalent in wild populations elsewhere in the United States (Adrian and

Keiss 1977). Because the symptoms are often difficult to interpret, serological testing is important in the diagnosis of Brucellosis, the most common type being an agglutination test used on serum or milk.

The State of Tennessee has been certified a "Brucellosis free state" for cattle by the US Department of Agriculture. This status does not mean that *Brucella abortus* is not found in Tennessee but that the Tennessee cattle industry has taken all necessary precautions and has a history of testing to document a "Brucellosis free" cattle program. This status allows Tennessee cattlemen to ship cattle from the state without extensive testing for Brucellosis, as required for states like North Carolina that do not have the "Brucellosis free" status.

Bovine Tuberculosis (TB): Bovine tuberculosis is caused by the bacterium *Myobacterium bovis*, which is distinct from *Myobacterium tuberculosis* of human origin. Among ruminants, the disease is transmitted through air, contaminated feed, or water. Infected animals lose weight, develop extensive pulmonary lesions, as well as lesions in the serous membranes, uterus, spleen and liver. *Myobacterium bovis*, which is also pathogenic to humans and most mammals, is usually transmitted by ingesting raw milk. The infection then spreads from the digestive to the respiratory tract and initiates the classic symptoms of tuberculosis. Inhalation of very fine infected particles is the main mode of animal-to-animal transmission (Kleeburg 1975) but urine and feces also contain the bacilli. Thus, animals are likely to infect each other when they share pasture or a common watering place.

Most states in the United States, including Tennessee and North Carolina, are accredited TB free. However, formerly TB-free states have occasionally found cases of TB in cattle that were traced to infection from captive cervids, among which the incidence of TB seems to be more common (Nettles and Corn 1998). Most wild cervids in the United States are free of TB, but the discovery of a high incidence of TB in free-ranging white-tailed deer in Michigan in 1994 suggests that the disease could establish in wild ruminants and spill over to domestic herds.

Infected ruminants do not usually display obvious symptoms and may take several months or years before they develop clinically recognizable signs of TB. Thus, laboratory tests are necessary to detect carriers or dead animals must be necropsied. Tests, described in the Tuberculosis Eradication in Cervidae Uniform Methods and Rules (USDA APHIS 1996), include the single cervical test, the comparative cervical tuberculin test, and serological tests.

Paratuberculosis: Paratuberculosis or Johne's disease is caused by the bacterium *Mycobacterium paratuberculosis.* This clinical disease has been important in farmed red deer in Europe and New Zealand (Vance 1961, Smits 1991, De Lisle et al. 1993). However, there has been only one report of spontaneous infection in wild elk in North America (Jessup et al. 1981) and that was in an elk herd associated with dairy cattle and known - infected exotic cervids (Riemann et al. 1979). The elk in this herd remained infected for 13 years, including six years without observed clinical signs (Cook et al. 1997). Experimental inoculation revealed that elk can harbor the organism for one year without clinical signs (Williams et al. 1983). One survey for the organism involving several hundred wild elk in Wyoming and Montana did not reveal

evidence of infection (Rhyan et al. 1997). The extent to which elk could serve as an important new reservoir or disseminator species of paratuberculosis is unknown.

Although this disease is endemic in cattle in the Southeast, there is no evidence that the abundant white-tailed deer, which are susceptible to infection, are serving as an epidemiologic factor at present in the region. The same statement can be made for elk in the western United States (Nettles and Corn 1998).

Elaphostrongylus cervi: This nematode parasite is found in red deer in Europe and New Zealand and was introduced into Canada among approximately 8,000 red deer imported from New Zealand for use in deer farming (Amen 1994). *Elaphostrongylus cervi* is neurotropic and has been reported to cause neurologic disturbances in mule deer, a non-definitive host (Gadjahar and Tessaro 1995).

This parasite has not been reported in wild elk in North America and there would appear to be no risk of introducing this parasite via wild elk from the United States. The only potential hazard would be if farmed elk from an undetected, infected herd in Canada were substituted for wild elk. An effective treatment for this nematode has not been developed (Nettles and Corn 1998).

Septicemic pasteurellosis: The bacterium *Pasteurella multocida* has been reported to cause pneumonia in elk (Cowan 1951, Murie 1951, Franson and Smith 1988, Smits 1991, Smits 1992, Rhyan et al. 1997). The observation of pasteurellosis in elk is not unusual or alarming: however, the report of septicemic pasteurellosis in 48 elk within a large herd at the National Elk Refuge in Jackson, Wyoming, may be of significance (Franson and Smith 1988). Septicemic pasteurellosis is an acute infection which may be the result of infection of highly pathogenic strains of *Pasteurella multocida* (stereotypes B:2 and E:2) that are uncommon in North America but are endemic in parts of Europe, Africa, the Near East, and South Asia. Hemorragic septicemia due to serotype B:2 was confirmed in bison in 1922; other reports were made in 1912 and 1965 (US Animal Health Association 1992). Hemorragic septicemia due to serotype 3 was reported in the National Elk Refuge in Wyoming (Franson and Smith 1988) and on state feed grounds in Wyoming (Nettles and Corn 1998). Septicemic pasteurellosis has only been identified in the National Elk Refuge herd in the United States (Nettles, personal communication 2000).

***Echinococcus granulosis*, (a species of tapeworm):** This parasite is a microscopic tapeworm whose adult phase is spent in the intestinal tracts of large canids. The larval stage occurs as large larval cysts in the lungs of elk and other wild cervids (Levine 1978). Ungulates contract the larvae through ingesting food or water contaminated with canid feces. Ingesting the viscera of infected wild or domestic ungulates infects canids. Thus, the parasite's life cycle is dependent on the predator-prey relationship between canids and ungulates (Nettles and Corn 1998). The larval stage does not seem to seriously harm wild ungulate hosts but infected domestic ungulates and humans may sometimes be adversely affected (Rausch 1975).

Humans occasionally contract the larvae through sustained exposure to infected dogs and usually by transfer of embryophores from paws or dog hair. *Echinococcus granulosus* larvae cause cystic hydatid disease in humans with clinical symptoms that vary depending on the localization

of the larvae and the strain of *Echinococcus granulosus* (Rausch 1975). Cysts most commonly form in the lungs or liver and are less serious unless they become unusually large and rupture. Intracardiac cysts may result in sudden death (di Bello and Menendez 1963). Cysts that rupture in the abdominal organs may lead to the spread of secondary cysts into the peritoneal cavity, often with enlargement of the abdomen. Occasionally, metastatic foci may establish in the brain creating serious complications. Domestic animals with large infestations of *Echinococcus granulosus* larvae may have enlarged livers or other organs where cysts localize. Secondary effects, such as decreased production of wool and milk, decreased growth, and secondary disease are additional consequences.

Echinococcus granulosus is endemic in California and adjacent states where it is essentially a coyote-deer parasite. In Canada, it is also maintained as a wolf-moose or coyote-elk parasite. The parasite is not reported in the Southeast. According to Rausch (1975), the larvae of indigenous strains in Alaska and Canada do not often develop in domestic ungulates and rarely cause complications in humans but this assertion has not been definitively tested. Since coyotes and foxes occur at GRSM, it is feasible that the experimental release of elk to GRSM could result in the establishment and spread of the parasite beyond the extent of the Park and adjacent areas. Both elk and canids are highly mobile animals. Up to 21 percent of the elk at Elk Island National Park (EINP) are infected with the disease, (Samuel, personal communication 1998). There is no known method for treating cervids infected with *Echinococcus granulosus*, nor are there standard tests to diagnose the parasite in elk.

Giant Liver Fluke (*Fascioloides magna*): The giant liver fluke of deer and elk is not highly pathogenic for cervids but can cause serious necrotizing hepatitis in domestic sheep and extensive liver tissue damage in cattle. This trematode parasite is present in many areas of the Southeast. However, the current distribution is patchy and possibly could be explained by the relocation of infected white-tailed deer (Pursglove et al. 1977). An alternate hypothesis is that the parasite's distribution in the region is determined by habitat factors, which in turn influence the abundance of aquatic snails that are required to complete the giant liver fluke's life cycle. The current endemic area is primarily in the coastal areas and river bottoms of the Deep South (Pursglove et al. 1977, Malone 1986). However, the parasite is also found in scattered areas within the piedmont and interior low-plateau physiographic provinces (Nettles and Corn, 1998).

Non-endemic species of ticks: Two species of ticks, *Dermacentor andersonii* and *Ixodes pacificus* are considered high risk (Nettles and Corn 1998) because they are not found in the southeastern United States and because they may facilitate the transmission of certain viruses or bacteria that are pathogenic to humans. *Dermacentor andersonii*, the Rocky Mountain wood tick, is distributed throughout most of western North America. It is a vector of Colorado tick fever virus, Rocky Mountain spotted fever, anaplasmosis, tularemia, and tick paralysis (Burgdorfer 1975, Schmidt and Roberts 1989). *Ixodes pacificus*, which is a vector of Lyme disease, is found on deer, cattle, and other mammals in elk range along the West Coast of California, Oregon and Washington. Some insects, as well as species of *Dermacentor* and *Ixodes*, in the Southeast, also serve as vectors for these same diseases. Thus, the main risk incurred through introducing *Dermacentor andersonii* and *Ixodes pacificus* is to provide additional vectors to facilitate the transmission of tick-borne disease.

Mites *(Psoroptes):* Mites of the family Psoroptidae pierce the skin of host animals (mostly ungulates) causing psoroptic mange characterized by skin inflammation and hair loss. Skin inflammation leads to exudation that partially hardens to form loose scabs. Severe cases of mange can result in hypothermia and death (Harwood and James 1979). Infestations by *Psoroptes* mites are highly contagious, owing to the looseness of the scabs formed on the skin and the hardiness of the mites (Harwood and James 1979). Outbreaks of psoroptic mange in domestic cattle or sheep can result in severe economic losses and requires strict quarantine measures to prevent further outbreaks. Several parasiticides (e.g., gamma benzene hexachloride, or gammexane) are effective in killing the mites in infected animals and can be used prior to shipment. The genus of *Psoroptes* that parasitizes elk may be host-specific for elk and bighorn sheep (Sweatman 1958). In this case, introduction of the parasite would be detrimental to a future elk population.